COMMONWEALTH of VIRGINIA

Ecological Communities of the Jamestown Island 400th Anniversary Planning Project Area, Colonial National Historical Park, Virginia

Prepared for
United States Department of the Interior

National Park Service

FINAL REPORT

Virginia Department of Conservation and Recreation
Division of Natural Heritage
Natural Heritage Technical Report 02-07
March 2002

DCR
Department of Conservation & Recreation
CONSERVING VIRGINIA'S NATURAL AND RECREATIONAL RESOURCES

ECOLOGICAL COMMUNITIES OF THE JAMESTOWN ISLAND 400TH ANNIVERSARY PLANNING PROJECT AREA, COLONIAL NATIONAL HISTORICAL PARK, VIRGINIA

Natural Heritage Technical Report 02-07
March 2002

by

Joseph T. Weber and Philip P. Coulling
Virginia Department of Conservation and Recreation
Division of Natural Heritage
217 Governor Street, 3rd Floor
Richmond, Virginia 23219

prepared for

United States Department of the Interior
National Park Service
Colonial National Historical Park
P.O. Box 210
Yorktown, Virginia 23690

This report should be cited as follows:
Weber, J.T., and P.P. Coulling. 2002. Ecological communities of the Jamestown Island 400th Anniversary Planning Project Area, Colonial National Historical Park, Virginia. Natural Heritage Technical Report 02-07. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 42 pp. plus appendices.

SUMMARY

This report presents a classification of ecological communities of the Jamestown Island 400th Anniversary Planning Project Area, Colonial National Historical Park, Virginia. The goals of the study were to develop a community classification based on existing vegetation and remotely sensed data, to produce a digital map of recognized communities, and to crosswalk the classification to units in the U.S. National Vegetation Classification (USNVC). One extensive upland forest type, two localized palustrine forest types, and six tidal marsh types were classified based on 19 quantitative vegetation sample plots and reconnaissance observations. Each of these types was synonymized with a USNVC alliance. The classification of tidal marsh communities was refined through analysis of a regional data set of over 400 plots. One of the specific community types present in the study area may be globally rare.

ACKNOWLEDGMENTS

Funding for this project was provided by the United States Department of the Interior, National Park Service, through cooperative agreement number 4000-8-9027-2. We wish to thank the staff of Colonial National Historical Park, particularly Charles Rafkind for his contributions and support. The Association for the Preservation of Virginia Antiquities graciously allowed us access to their property so we could search for significant communities. We also thank our fellow staff of the Virginia Department of Conservation and Recreation, Division of Natural Heritage, for their assistance. Nancy Van Alstine gave us a guided tour of the project area and directed us to some interesting communities. Gary Fleming, Johnny Townsend, Dean Walton, Nancy Van Alstine, and Allen Belden Jr. provided help in identifying plant specimens. Tom Smith and Rhonda Houser assisted with field surveys. Karen Patterson provided insightful guidance in crosswalking vegetation types to the U.S. National Vegetation Classification. Chris Ludwig secured funding and managed the project. Pat Jarrell and Faye McKinney handled administrative tasks.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

On 21 March 2001 the United States Department of the Interior, National Park Service, and the Virginia Department of Conservation and Recreation, Division of Natural Heritage, entered into Amendment No. 2 to Supplemental Agreement No. 2 to Cooperative Agreement 4000-8-9027 to undertake biological inventory in the Jamestown Island 400th Anniversary planning project area. This report presents the results of investigation and analysis of the vegetation of the project area. An additional report (Chazal and Van Alstine 2001) documents the location and status of rare, threatened, and endangered plant and animal species in the project area.

The purpose of the ecological inventory was threefold:

- To develop a coarse classification of natural communities based on extant vegetation
- To generate a map of vegetation types using a Geographic Information System and based on field data and interpretation of remote imagery
- To crosswalk the coarse vegetation types to alliances in the U.S. National Vegetation Classification.

Natural Heritage Methodology

The Virginia Department of Conservation and Recreation, Division of Natural Heritage (DCR-DNH), is the state agency charged with the responsibility, by statutory authority under the Virginia Natural Area Preserves Act, for the inventory, protection and management of Virginia's natural heritage resources. Natural heritage resources are defined as "the habitat of rare, threatened, or endangered plant and animal species, rare or state significant natural communities or geologic sites, and similar features of scientific interest" (Virginia Natural Area Preserves Act, Section 10.1-209 through 219, *Code of Virginia*). The Division conducts the only comprehensive effort to identify and document the Commonwealth's most significant natural areas through continuing biological survey. Data gathered in this statewide inventory are assembled into a sophisticated Biological and Conservation Datasystem (BCD), a comprehensive database in which information on species and communities and their location, status, habitat, biology and conservation needs is stored and revised. DCR-DNH belongs to an international network of state natural heritage programs and conservation data centers that use a standard methodology for the collection and management of data.

Each of the significant natural features (including plant and animal species, communities, and caves) that DCR-DNH monitors is considered an **element** of natural diversity. Each element is assigned a rank based on its relative rarity. The total number of occurrences represents the principal criterion for ranking elements; other considerations include the size and condition of individual occurrences, the number of protected occurrences, and ongoing threats to the health or stability of occurrences. Two ranks are assigned to each element to reflect its rarity within Virginia (State or S-rank) and over its entire range of distribution (Global or G-rank). Combined ranks (*e.g.*, S2S3) are acceptable for intermediate or uncertain status. These rarity ranks are not legal designations and should not be interpreted as such; they are continually updated to reflect newly gathered information. Criteria for determining S-ranks for communities are listed below;

similar criteria apply to G-ranks, for which the full range of an element is considered, and to individual species.

S1 Extremely rare, generally with ≤ 5 occurrences statewide; or covering < 50 ha (124 acres) in aggregate; or covering larger area but highly threatened with destruction or modification).
S2 Very rare, generally with 6-20 occurrences statewide; or covering < 250 ha (618 acres) in aggregate; or covering larger area but threatened with destruction or modification).
S3 Rare to uncommon, generally with 21-100 occurrences statewide (may be of relatively frequent occurrence in restricted geographic regions of the state); or with a larger number of occurrences but subject to relatively high levels of threat.
S4 Common, at least in certain regions of the state, and apparently secure.
S5 Very common and demonstrably secure.
SW Ruderal vegetation or vegetation dominated by invasive alien species (applies only to communities).
SM Vegetation extensively modified by anthropogenic disturbance, but considered recoverable by management, time or restoration of natural ecological processes (applies only to communities).
S_? Rank uncertain or approximate.

The location on the landscape that supports a natural heritage resource is referred to an **element occurrence**. Distinct, separate but neighboring locations of an element may be treated as sub-occurrences of the same single occurrence, if they are likely to be linked through gene flow or ecological processes. DCR-DNH has identified and mapped over 9500 occurrences of 1666 elements in Virginia. Information regarding the location, quality and status of each element occurrence is stored in BCD and recorded in digital and manual files, on maps, and in a Geographic Information System (GIS).

In addition to ranking each element, DCR-DNH ranks each element occurrence according to quality, so that large, outstanding occurrences can be differentiated from small, more vulnerable or poorer ones. Thus, the Division is able to target conservation and protection efforts not simply at the rarest elements, but at the best examples of each. Community element occurrences are ranked based on size, condition (considering, for example, stand age, maintenance of natural processes, and degree of anthropogenic disturbance), and condition of vegetation in the surrounding landscape (e.g., extent of intact natural communities). **Element occurrence ranks** range from A (excellent) to D (poor); combined ranks may be assigned for intermediate or uncertain status. Where field data are insufficient to permit a complete, reliable assessment of quality, a rank of E (extant) may apply. Consistent with the Division's mission not only to conduct an inventory of the biodiversity of Virginia but also to practice active protection and stewardship, a poorly-ranked element occurrence may be reassigned a higher rank with successful management or restoration.

Ranks for elements and element occurrences constitute the basis for ranking the overall significance of **conservation sites** containing one or more noteworthy element occurrences. These site **biodiversity ranks** (B-ranks) are used to prioritize protection and management efforts. B-ranks are defined as follows.

B1 Outstanding significance: the only known site for an element or an excellent occurrence of a G1 element.

B2 Very High Significance: the most outstanding occurrence of any community, a good occurrence of a G1 species, or an excellent example of a G2 or G3 species.

B3 High Significance: an excellent example of any community or a good occurrence of a G3 species.

B4 Moderate Significance: a good example of any community or an excellent or good occurrence of a state-rare species.

B5 General Biodiversity Significance: a good or fair occurrence of any community or state-rare species.

United States National Vegetation Classification

The inventory and classification of natural communities constitute an important "coarse-filter" approach to biological conservation that ensures the protection of diverse organisms. The identification and protection of excellent examples of all natural community types facilitates the protection of the majority of component native plant and animal species, including a host of taxa too cryptic, poorly known, or numerous to receive individual management strategies.

Conservation ranks for communities are at best only provisional and in most instances lacking entirely, because a universal taxonomic system for ecological communities, analogous to that for biological species, does not yet exist. Such a system, the United States National Vegetation Classification (USNVC; Grossman *et al*. 1998, Anderson *et al*. 1998), is being developed by a consortium of partners which include NatureServe (formerly the Association of Biodiversity Information), The Nature Conservancy, the network of state Natural Heritage Programs, the Federal Geographic Data Committee, and the Vegetation Panel of the Ecological Society of America. This endeavor represents an ambitious attempt to classify all existing vegetation in the United States across a range of spatial scales and degrees of conceptual resolution. Vegetation is considered a surrogate for other biological components, ecological processes, and environmental conditions. Upper levels of the hierarchical classification are based on physiognomic criteria such as dominant life forms, vegetation structure, and leaf phenology. The two lowest divisions, the *alliance* and the *association*, are based on floristic criteria. The association, constituting the basic unit of inventory and biodiversity assessment, serves as a surrogate for natural communities.

At present DCR-DNH classifies communities at the level of *ecological community group*, which represents a broadly defined unit based on combinations of topographic, edaphic, physiognomic, and gross floristic similarities (Fleming et al. 2001). S-ranks have not been assigned to these units, and G-ranks are not applicable, since ecological community groups are not defined at a single, standard scale and do not correspond to a single level of the USNVC hierarchy. DCR-DNH ecologists have undertaken the classification of *community types* at a finer level of resolution. These types are nested within ecological community groups, and community types within a given ecological community group share definite environmental, structural and floristic similarities. S-ranks will ultimately be assigned to all community types.

Mapping

The mapping of natural communities is an important extension of community classification. Maps can provide a practical tool for applying classifications to conservation problems such as protection of rare community types, protection of flora and fauna associated with specific community types, and development of specific management prescriptions to ensure the continued viability of key community types and community mosaics.

STUDY AREA

Physiography

The Jamestown Island 400th Anniversary Planning Project Area (hereafter, project area) lies within the Coastal Plain physiographic province (Fenneman 1938) and comprises 917 ha (2267 acres) in the western end of Colonial National Historical Park (CNHP). The area is entirely within James City County. Elevation ranges from ca. 4.5 m (15 ft) to essentially sea level at Back and James Rivers and along tidal tributaries. Tidal channels are flooded twice daily by lunar tides, with tidal amplitude up to ca. 1 m (3.3 ft). Relief is very gentle, although slight variation in elevation can exert pronounced ecological influence. For example, the transition from terrestrial to estuarine tidal habitat may occur over an abrupt elevational gradient of < 1 m, and even more subtle relief in upland terrain may affect local hydrology and the distribution of non-tidal palustrine microhabitats, such as saturated or seasonally flooded sites.

Climate

Thirty-year (1961-1990) mean climatological data are available for Williamsburg (Virginia State Climatology Office: http://climate.virginia.edu). The mean monthly minimum temperature is 8.3º C (46.9º F), and the mean monthly maximum is 20.9º C (69.6º F). The mean January minimum temperature is –2.9º C (26.7º F), and the mean July maximum is 31.2º C (88.2º F). Annual precipitation averages 119.6 cm (47.08 in), with snowfall of 25.4 cm (10.0 in).

Geology

The 1:500,000 geologic map of Virginia (Virginia Division of Mineral Resources 1993, Rader and Evans 1993) depicts parent material of the entire project area as undifferentiated Quaternary and Tertiary deposits, save for two small portions at the northern and northeastern extremes, which are underlain by the Sedgefield Member, consisting of clayey and shelly sand grading to sandy and clayey silt. A finer-scale map (Mixon et al. 1989) distinguishes between Quaternary alluvium, comprising sand and sandy gravel, silt, and clay, in wetlands and the Poquoson Member, consisting of medium to coarse pebbly sand grading to clayey fine sand and silt, in the interior uplands.

Soils

Soils in the project area exhibit considerable fine-scale variation, but consistent patterns are also evident within upland and tidal wetland areas (Hodges et al. 1985). The tidal marshes along Back River are underlain Levy soils (entisols). In the narrow upland fringe between these marshes and the Colonial Parkway, soils belong primarily to the Pamunkey series (alfisols), but Craven, Uchee, Emporia, Dogue (all ultisols), and Johnston (inceptisols) are present locally. The interior uplands (roughly the terrain followed by the loop drive) contains chiefly State and Tetotum series soils (both ultisols), with lesser amounts of Craven, Uchee, Dogue, Levy, Newflat (ultisols), and Chickahominy (ultisols). Marshes along Kingsmill and Passmore Creek are underlain primarily by soils of the Bohicket series (entisols), except for the upper tidal reaches of Passmore Creek, which contain Levy soils. Upland fingers that interdigitate with tidal channels

in the southernmost portion of the project area contain State, Tetotum, Dogue, Dragston (ultisols), Newflat, Bojac (entisols), and Seabrook (entisols) soils. Alluvial beach deposits occur along the James River. The developed portion of the project area contains a mosaic of Emporia, Bethera (ultisols), Dogue, Tetotum, Kenansville (ultisols), Chickhominy, Newflat, Pamunkey, State, and Levy series soils. The causeway is composed of allochthonous udorthent material.

METHODS

Field Methods

Data on species composition, physiognomy, and site conditions were collected from a set of sample plots established in representative vegetation throughout the project area. Prior to field sampling digital remote imagery and a preliminary land cover map were consulted to guide quantitative inventory. DCR-DNH Field Botanist Nancy Van Alstine provided additional information about the location and condition of particular vegetation types. Plot locations were determined subjectively in order to capture both homogeneous vegetation within stands and to document a wide range of compositional variation across the landscape. Stands that had evidently experienced recent disturbance, were adjacent to developed portions of Colonial National Historical Park, or had been severely altered by anthropogenic influence were intentionally avoided. These restrictions greatly limited the extent of upland forest habitat suitable for quantitative sampling, since invasive exotic plant species pervade much of the study area. Uncommon, locally restricted, distinct vegetation types were likely oversampled relative to their extent on the landscape, whereas widespread types were not sampled in proportion to their distribution.

Data collection followed standard procedures employed by DCR-DNH ecologists. Forest vegetation was sampled in 400 m^2 plots; 100 m^2 plots were established in marsh vegetation. Plots were typically square, but rectangular configurations were used in some instances to conform to the dimensions of small vegetation patches and to minimize compositional heterogeneity within a plot. Within each plot the presence of all vascular plant species was recorded and estimated percent cover assigned to one of nine cover class scales (Table 1).

Table 1. Cover class scale used in field data collection.

Cover Class	Range of Percent Cover
1	0 – 0.1%
2	0.1 – 1%
3	1 – 2%
4	2 – 5%
5	5 – 10%
6	10 – 25%
7	25 – 50%
8	50 – 75%
9	75 – 100%

Plot locations were recorded using a handheld Global Positioning System (GPS) unit (Trimble GeoExplorer III). GPS files were post-processed by differentially correcting positions using available base station data. Where topographic relief was evident and slope azimuth apparent, slope inclination and aspect were measured, generally from the plot center. The percent cover of each of five classes of surface substrate (bryophytes and lichens, decaying wood, mineral soil, organic matter (chiefly litter), and water) was estimated visually; recorded precision varied so

that values (except that of bryophyte and lichen cover) summed to unity. (Percent cover of exposed boulders, stones, cobbles, and gravel is also measured in the standard DCR-DNH protocol, but no surficial lithologic material was present in this landscape.) Topographic position, slope curvature, soil moisture regime, soil drainage class, inundation, and hydrologic regime were assessed using ordinal scalar variables (Table 2).

A sample of mineral soil from the A horizon was collected from each plot, either as a single sample from near the plot center or as a composite of samples distributed throughout the plot. A mass of 300 – 1000 g was typically extracted to a depth of ca. 10 cm (4 in). Despite efforts at consistency, variation in surface substrate, standing water, and root biomass precluded the extraction of soil to a standard depth in marsh sediments. Samples were dried at ca. 70° C for 48 hr, sieved, and analyzed for pH, cation exchange capacity (meq/100g), percent organic matter, estimated N release, easily extractable P, soluble S, exchangeable cations (Ca, Mg, K, Na ppm), percent base saturation (= %Ca + %Mg + %K + %Na), and extractable micronutrients (B, Fe, Mn, Cu, Zn, Al ppm). Elemental concentrations were determined using the Mehlich III extraction technique (Mehlich 1984), organic matter was measured by loss on ignition, and pH was measured using a 1:1 soil:water solution. Chemical analysis was performed by Brookside Laboratories, Inc., New Knoxville, Ohio.

The physiognomy of forest stands was quantified by measuring the size distribution and vertical stratification of woody plants. Additional cover estimates were made for woody species present in each of three broadly defined vertical strata: canopy (overstory), shrub (understory; > 0.5 m), and herb (ground layer; < 0.5 m). The diameter at breast height (1.4 m [4.6 ft]; dbh) of each woody stem (trees, shrubs, and lianas) was tallied by size class using a metric Biltmore stick. The classes used were 0-1, 1-2.5, 2.5-5, 5-10, 10-15, 15-20, 20-25, 25-30, 30-35, and 35-40 cm. Stems $\geq$ 40 cm (15.7 in) were measured directly with a dbh tape to the nearest 1 cm (0.4 in). These data were used to calculate density, basal area, and importance value.

All vegetation sampling was conducted from August to October 2001. A total of 19 plots were sampled, 10 in estuarine tidal marsh, seven in upland forest, and two in palustrine forest communities.

Data Analysis

Hierarchical cluster analysis using the flexible-beta, or Lance-Williams (Lance and Williams 1967), strategy was used to produce a classification of vegetation types. A dissimilarity matrix using the coefficient of community (Bray and Curtis 1957) was computed from raw cover class scores of all species; the value of beta was set at -0.25. Cluster analysis was performed in PC-ORD, version 4.14 (McCune and Mefford 1999). Clusters of compositionally similar vegetation were identified subjectively from inspection of the resulting dendrogram of plots. These clusters were further examined for consistency in species composition, vegetation structure, and site conditions. The assignment of tidal marsh plots to groups was refined through the preliminary analysis of a larger set of 407 plots representing tidal marsh, tidal shrub swamp, and salt scrub vegetation from the Coastal Plain of Virginia. This exercise resulted in the reclassification of one plot from the Jamestown Island project area.

Table 2. Scalar ordinal variables used to assess topographic and site moisture characteristics.

Topographic Position
A – plain/level
B – toe
C – lower slope
D – middle slope
E – upper slope
F – escarpment / face
G – ledge / terrace
H – crest
I – basin / depression
J – floodplain
K – stream bottom

Slope Curvature – Horizontal and Vertical
C – concave
S – straight
X – convex

Soil Drainage Class
A – very poorly drained
B – poorly drained
C – somewhat poorly drained
D – moderately well drained
E – well drained
F – rapidly drained

Inundation
A – never
B – infrequently
C – regularly for < 6 months
D – regularly for > 6 months
E – always submerged; < 30 cm
F – always submerged; > 30 cm

Soil Moisture Regime
A – very xeric (moist for negligible time after precipitation)
B – xeric (moist for brief time)
C – somewhat xeric (moist for short time)
D – submesic (moist for moderately short time)
E – mesic (moist for significant time)
F – subhygric (wet for significant part of growing season; mottles <20cm)
G – hygric (wet for most of growing season; permanent seepage/mottling)
H – subhydric (water table at or near surface for most of the year)
I – hydric (water table at or above surface year round)

Hydrologic Regime
Tidal:
- A – irregularly exposed
- B – regularly flooded
- C – irregularly flooded
- D – wind tidally flooded

Non-Tidal:
- A – permanently flooded
- B – semipermanently flooded
- C – seasonally flooded
- D – intermittently flooded
- E – temporarily flooded
- F – saturated

Halinity (ppt salt):
- A – freshwater (< 0.5 ppt)
- B – oligohaline (0.5 – 5 ppt)
- C – mesohaline (5 – 18 ppt)
- D – polyhaline (18 – 30 ppt)
- E – euhaline (30 – 40 ppt)
- F – hyperhaline (> 40 ppt)

Recognized vegetation types were crosswalked to existing alliances in the USNVC. Most of the communities in the project area corresponded adequately to units already described in the USNVC, but the two locally restricted palustrine forest communities (represented by plots 3 and 17) had very poor matches. In addition the classified vegetation types were crosswalked to the DCR-DNH classification of ecological community groups and a provisional classification of tidal community types.

Botanical nomenclature follows Kartesz (1999).

Mapping

The National Park Service provided a high resolution (1 m), 1:7200 scale, color, aerial image of the study area that was collected in February 1997. This digital basemap file was compressed with MrSID software and named Ji_7200_color_nad83.sid. The image was projected in UTM, NAD 1983 (modified header), Zone 18, with units set as meters. The NPS also provided a vegetation layer, named Ji400_vegpo.shp, which depicted very general natural and artificial vegetation types found in the project area. This map was modified using ArcView, version 3.2 (Environmental Systems Research Institute 1992-1999), to produce a map of Natural Heritage ecological communities. First, all artificially maintained vegetation and infrastructure were removed. The layer was then edited to delineate certain communities, such as mud flats, that were large and had distinctive visual signatures (i.e., they were readily identifiable) in the MrSID image. The polygons of the layer were then assigned to USNVC alliances using plot information and expert knowledge about the locations of vegetation communities within the project area.

RESULTS

Floristics

A total of 103 vascular plant taxa were sampled in the 19 plots (Table 3). Only one of these, *Peltandra virginica* (arrow-arum), occurred in more than half the plots. Upland forest and tidal marsh vegetation comprised nearly altogether different floras, with only one species (*Cinna arundinacea* [wood reedgrass]) in common. The 10 marsh plots captured 38 species, seven of which occurred in at least half of the plots: *Peltandra virginica*, *Polygonum punctatum* (dotted smartweed), *Schoenoplectus tabernaemontani* (soft-stem bulrush), *Amaranthus cannabinus* (waterhemp pigweed), *Rumex verticillatus* (swamp dock), *Spartina cynosuroides* (giant cordgrass), and *Zizania aquatica* var. *aquatica* (wild rice). Forty-nine species occurred in the seven upland forest plots. Nineteen of these were present in more than half of these plots, and three (*Liquidambar styraciflua* [sweetgum]), *Smilax bona-nox* [upright greenbrier], and *Smilax rotundifolia* [common greenbrier]) occurred in every upland sample. Species richness averaged 10.6 taxa ·100 m^{-2} in the marsh plots and 20.3 taxa · 400 m^{-2} in the upland forest plots. Each of the sampled palustrine forest communities contained 23 species in a 400 m^2 plot. No state or globally rare species was sampled, but *Eleocharis rostellata* (G5/S3) and *Solidago sempervirens* var. *mexicana* (G5T?/S3), both watchlisted species in Virginia (Townsend 2001), were captured in two and one plots, respectively.

Vegetation Classification

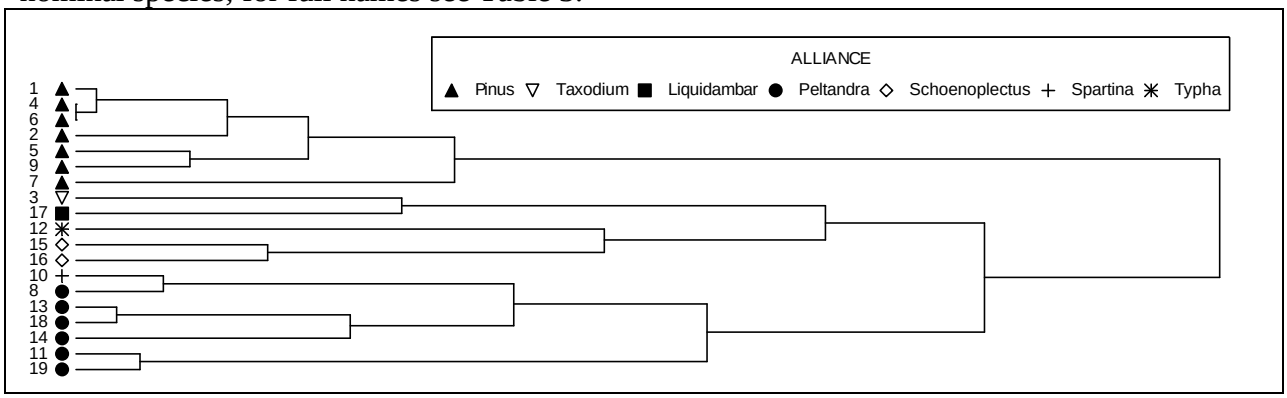
Cluster analysis of the 19 plots revealed six distinct groups at a level of $r^2 = 0.547$ (Figure 1). A clear division is evident between the seven upland forest plots and the remaining estuarine herbaceous and palustrine forest plots. Further analysis of the 10 tidal marsh samples within a larger data set of 407 plots representing tidal marsh and tidal shrub swamp vegetation largely confirmed the results of the initial cluster analysis. One plot (plot 10) was reassigned to a separate group based on the more comprehensive analysis, which resulted in a final classification of seven sampled vegetation types in the project area.

Within the context of the Jamestown Island data set, each of these types encompassed sufficiently consistent and distinct species composition that it could be circumscribed adequately. Five of these types could comfortably be crosswalked to existing alliances in the USNVC (Table 4). The remaining two types, each representing a palustrine forest community captured by only a single plot, proved problematic because of the extremely small size of the stand (in both instances barely larger than the plot), uncertain hydrology, and apparently singular occurrence within the project area. The classification of plots 3 and 17 must thus be considered provisional. Two additional alliances were observed but not quantitatively sampled. The *Phragmites australis* Tidal Herbaceous Alliance, was detected in small to moderately sized patches in the mosaic of marshes along Back River, Passmore Creek, and Powhatan Creek. Although these stands were neither sampled nor delimited, the vegetation type is included in the classification because its identity and correspondence to the USNVC are unequivocal. Vegetation belonging to the *Zizania aquatica* Tidal Herbaceous Vegetation appears to be present in the interior of marshes along Back River and along Powhatan Creek.

Table 3. Frequency of occurrence of all vascular plant taxa recorded from 19 vegetation sample plots.

Freq	Species	Freq	Species
10	Peltandra virginica	2	Elymus virginicus var. halophilus
9	Polygonum punctatum	2	Forb sp.
8	Liquidambar styraciflua	2	Myrica cerifera
8	Pinus taeda	2	Persea palustris
8	Smilax rotundifolia	2	Quercus falcata
8	Toxicodendron radicans	2	Spartina patens
7	Acer rubrum	1	Andropogon virginicus
7	Chasmanthium laxum	1	Aralia spinosa
7	Smilax bona-nox	1	Asplenium platyneuron
6	Ilex opaca var. opaca	1	Baccharis halimifolia
6	Juniperus virginiana var. virginiana	1	Baptisia tinctoria
6	Rumex verticillatus	1	Boehmeria cylindrica
6	Sassafras albidum	1	Carex pensylvanica
6	Schoenoplectus tabernaemontani	1	Carya alba
6	Spartina cynosuroides	1	Cephalanthus occidentalis
5	Amaranthus cannabinus	1	Cicuta maculata var. maculata
5	Dichanthelium dichotomum	1	Cornus florida
5	Microstegium vimineum	1	Cornus foemina
5	Nyssa sylvatica	1	Cyperus filicinus
5	Quercus alba	1	Eleocharis parvula
5	Vitis rotundifolia	1	Eupatorium capillifolium
5	Zizania aquatica var. aquatica	1	Fraxinus pennsylvanica
4	Carex complanata var. hirsuta	1	Galium sp.
4	Carex sp.	1	Gaylussacia baccata
4	Cinna arundinacea	1	Hedera helix
4	Danthonia spicata	1	Hieracium gronovii
4	Echinochloa walteri	1	Ilex decidua
4	Hibiscus moscheutos ssp. moscheutos	1	Juncus sp.
4	Panicum virgatum var. virgatum	1	Leersia virginica
4	Pluchea odorata	1	Liriodendron tulipifera
4	Prunus serotina var. serotina	1	Ludwigia palustris
4	Quercus stellata	1	Lythrum lineare
4	Quercus velutina	1	Mikania scandens
4	Sagittaria lancifolia	1	Oxalis dillenii
4	Schoenoplectus pungens	1	Pilea fontana
3	Chimaphila maculata	1	Pityopsis graminifolia
3	Eleocharis palustris	1	Polygonum arifolium
3	Hydrocotyle verticillata var. verticillata	1	Pontederia cordata
3	Kosteletzkya virginica	1	Quercus laurifolia
3	Leersia oryzoides	1	Quercus pagoda
3	Parthenocissus quinquefolia	1	Quercus rubra
3	Schoenoplectus americanus	1	Quercus x beadlei
3	Schoenoplectus robustus	1	Robinia pseudoacacia
3	Thelypteris palustris var. pubescens	1	Sagittaria subulata
3	Typha angustifolia	1	Setaria magna
2	Carex hyalinolepis	1	Solidago sempervirens var. mexicana
2	Carya glabra	1	Symphiotrichum novi-belgii
2	Cyperus odoratus	1	Symphiotrichum subulatum
2	Dichanthelium commutatum	1	Taxodium distichum
2	Distichlis spicata	1	Teucrium canadense
2	Eleocharis rostellata	1	Typha x glauca

Figure 1. Dendrogram depicting the results of cluster analysis of 19 vegetation sample plots using the Lance-Williams flexible beta technique and the Bray-Curtis coefficient of community. Plot numbers appear at the far left of the dendrogram. Each plot is represented by a single horizontal line, or branch. Branches joined by a node at the left end of the dendrogram indicate more compositionally similar plots; the more dissimilar a pair of plots or group of plots, the farther to the right those branches are joined. Alliances are keyed by the genus of the first nominal species; for full names see Table 3.



Mapping

The map of Natural Heritage Ecological Communities (Appendix A: Figure 2) depicts natural communities within the project area. The *Pinus taeda – Quercus* (*alba, falcata, stellata*) Alliance, the only alliance representing upland forest vegetation in the project area, was mapped simply by relabeling the "forest" category on the existing GIS layer depicting coarse land cover types. Crude visual inspection of the aerial photography revealed that the land cover types matched forest signatures fairly well. The mapping of tidal marsh alliances is much less precise. The "brush" category on the land cover layer was dissolved with herbaceous tidal marsh, as distinct shrub vegetation was evident neither on the aerial imagery or from ground reconnaissance. The quantity of ground-truthed, plot-based data and the spectral resolution of the remotely sensed imagery were insufficient to enable more precise mapping of individual tidal marsh alliances. Thus, these are mapped primarily as a complex, which generally comprises oligohaline vegetation, although vegetation types typically associated with freshwater conditions may occur locally. This complex includes patches dominated by *Phragmites australis*, the locations of which were noted in the field but are not mapped in Figure 2. Only in the marshes along Back River and Powhatan Creek and one site along Passmore Creek is a slightly darker visual signature apparent; one vegetation plot and observations on the ground permitted the mapping of a few specific patches of the *Peltandra virginica – Pontederia cordata* Tidal Herbaceous Alliance.

Two discrete patches of palustrine forest vegetation are mapped as the *Nyssa* (*biflora, aquatica, ogeche*) Floodplain Seasonally Flooded Forest Alliance. Only one of these patches was quantitatively sampled (plot 17; see Appendix B: Figure 3). The other received a reconnaissance visit, which revealed only grossly similar composition and evidence of recent disturbance. For neither stand is the identification of hydrological regime confident; both stands occur proximate to tidally influenced vegetation but appear to be supratidal themselves. Assignment of both of

Table 4. Classification of ecological communities of the Jamestown Island 400th Anniversary Planning Project Area.

TERRESTRIAL SYSTEM

- *Pinus taeda – Quercus* (*alba, falcata, stellata*) Forest Alliance
  (plots 1, 2, 4, 5, 6, 7, 9)

PALUSTRINE SYSTEM

- *Taxodium distichum* Semipermanently Flooded Alliance
  (plot 3)

- *Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance
  (plot 17)

ESTUARINE SYSTEM

- *Peltandra virginica – Pontederia cordata* Tidal Herbaceous Alliance
  (plots 8, 11, 13, 14, 18, 19)

- *Schoenoplectus americanus* Tidal Herbaceous Alliance
  (plots 15, 16)

- *Spartina cynosuroides* Tidal Herbaceous Alliance
  (plot 10)

- *Typha* (*angustifolia, domingensis*) Tidal Herbaceous Alliance
  (plot 12)

- *Phragmites australis* Tidal Herbaceous Alliance
  (not sampled)

- *Zizania aquatica* Tidal Herbaceous Alliance
  (not sampled)

these stands to the same alliance was a conservative decision; they may represent two different vegetation types, but their extremely small size will likely preclude any more precise characterization.

Discrete, apparently non-forested and clearly non-tidal patches evident on aerial photography were interpreted as herbaceous wetland communities and are mapped as undifferentiated units. These sites were not inventoried and the putative palustrine (as opposed to estuarine tidal) hydrology was not verified. No information is available on species composition, and it is not possible to tag these communities to a single or even multiple alliances in the USNVC.

DESCRIPTIONS OF VEGETATION ALLIANCES

A standard format is used for the description of alliances to facilitate comparisons among units. This scheme is modified from the format adopted by Fleming and Moorhead (1998) and Newell *et al.* (1997), both of which reflect earlier work by Curtis (1959) and Rodwell (1991). Summary information is organized under the following headings.

Alliance – The name and code of the USNVC alliance are given. The alliance is the highest of the floristic levels in the USNVC and represents a group of vegetation types that share one or more diagnostic (i.e., dominant, differential, indicator or characteristic) species, which are generally found in the uppermost stratum of the vegetation.

Formation – The name and code of the USNVC formation to which an alliance belongs are given. The formation is the lowest of the physiognomic levels in the USNVC and represents a group of vegetation types that share a definite physiognomy or structure and broadly defined environmental factors, such as elevation or hydrology.

Composition and Physiognomy – A general description of vegetation composition and physiognomy of each alliance highlights patterns of dominance, floristic variation, and structure. The composition of vegetation samples in this study is described first, followed by a brief summary of the typical expression of the unit (if different), as described in the USNVC (NatureServe 2001). A complete list of vascular plant species recorded from representative samples (and density and basal area data for tree species in the *Pinus taeda* – (*Quercus alba, falcata, stellata*) Forest Alliance) follows each description. Common names are provided only for dominant or characteristic plant species in stands within the study area.

Habitat and Distribution – For each alliance the typical site characteristics and the known distribution within and beyond the study area are described.

Distinguishing Features – The diagnostic characteristics, both floristic and environmental, that distinguish each association from similar units are noted.

Comments – This section includes evidence of disturbance, successional trends, regional distribution, biodiversity and conservation status, and threats. Corresponding ecological community groups in Fleming et al. (2001) are noted. NatureServe does not assign conservation ranks to alliances, and no corresponding S-ranks are available. Tidal marsh communities have been provisionally classified at a finer level of resolution. For these communities preliminary S-ranks are presented, as are G-ranks for evidently comparable associations in the USNVC.

Representative Plots – A list of vegetation sample plots belonging to the alliance.

ALLIANCE:
***Pinus taeda – Quercus* (*alba, falcata, stellata*) Forest Alliance (A.404)**
Loblolly Pine - (White Oak, Southern Red Oak, Post Oak) Forest Alliance

Formation:
Mixed needle-leaved evergreen - cold-deciduous forest (I.C.3.N.a.)

Composition and Physiognomy:
The overstory is dominated by one or more species of oak (chiefly *Quercus alba* [white oak], *Q. velutina* [black oak], *Q. falcata* [southern red oak], and *Q. stellata* [post oak]), often in combination with *Pinus taeda* (loblolly pine) (Tables 5 and 6). *Liquidambar styraciflua* (sweetgum) is a constant component of canopy or subcanopy strata, and *Nyssa sylvatica* (black gum) is an important subcanopy species in many stands. Sites with ephemeral seepage or seasonally perched water tables may support occasional individuals of *Quercus laurifolia* (laurel oak) or *Q. pagoda* (cherrybark oak). Canopy height exceeds 35 m in three of the seven sampled stands. The understory is generally open, with scant tree regeneration (one plot has exceptionally high density of *Pinus* saplings) or a well-developed shrub stratum. *Ilex opaca* var. *opaca* (American holly) is a frequent constituent, although it only occasionally attains cover > 5%. *Cornus florida* and *Morella* (= *Myrica*) *cerifera* (common wax-myrtle) are moderately abundant in one stand each. Hickories (*Carya glabra* [pignut hickory], *C. alba* [mockernut hickory]) may be present but never co-dominate with oaks. The herb layer is sparse and depauperate. Although no herb species attains high cover in any plot (see *Comments*, however), several grass species occur with high constancy: *Chasmanthium laxum* (slender spikegrass), *Danthonia spicata* (poverty oat-grass), *Dichanthelium dichotomum* (forked witch-grass), and the exotic *Microstegium vimineum* (Japanese stilt-grass). The evergreen lianas *Smilax rotundifolia* (common greenbrier) and *S. bona-nox* (upright greenbrier) are present in every plot, but are restricted chiefly to ground-running stems. Species richness of sampled stands ranges from 15 to 27 taxa · 400 m^{-2}, with a mean of 20.

Throughout the range of this alliance, stand canopies are dominated by *Pinus taeda* with some combination of the nominal oaks; associated species vary by geography, substrate, and exposure. These may include *Carya alba, Carya texana, Nyssa sylvatica, Liquidambar styraciflua, Carya cordiformis, Magnolia grandiflora, Fagus grandifolia, Quercus velutina, Quercus michauxii, Quercus pagoda*, and *Acer rubrum*. The subcanopy can include canopy species, as well as *Ilex opaca* var. *opaca, Ostrya virginiana, Carpinus caroliniana,* and *Cornus florida*. *Callicarpa americana, Symplocos tinctoria, Morella cerifera, Vaccinium elliottii, Viburnum dentatum,* and *Viburnum acerifolium* are common shrub species. Herb species that may be present include *Polystichum acrostichoides, Athyrium filix-femina* ssp. *asplenioides, Phegopteris hexagonoptera, Prenanthes altissima, Spigelia marilandica, Mitchella repens, Podophyllum peltatum, Phlox divaricata, Tipularia discolor, Arisaema triphyllum, Erigeron pulchellus, Lilium michauxii, Chasmanthium laxum, Chasmanthium sessiliflorum,* and *Melica mutica*.

Habitat and Distribution:
Soils are predominantly well drained sandy or silt loams, with little organic matter and low base saturation. Relief is typically gentle, but this type also occurs on pronounced (though short) slopes in the northern portion of the project area. The prevalence of *Quercus stellata* suggests

the likelihood of a subsurface clay hardpan, but no evidence of such a feature was observed in the soil profile within 1 m of the soil surface.

Within the project area this alliance occurs in all upland terrain covered by native vegetation. It is most extensive in the central portion of the area, through which the loop drive is routed, and immediately south of the tidal marshes along Back River. The alliance ranges from Maryland and Delaware south to Georgia and west to Texas and possibly Oklahoma.

Distinguishing Features:
This alliance can be distinguished from all other alliances in the project area by its terrestrial habitat. All upland forests in this study are assigned to this alliance.

Comments:
Most stands at Jamestown Island have been significantly altered by anthropogenic disturbances. *Microstegium* is pervasive and nearly ubiquitous in the project area and forms extensive large patches with cover exceeding 75%. Stand selection for plot placement was severely constrained by the desire to minimize the inclusion of this species, which DCR-DNH considers highly invasive (Heffernan et al. 2001). This species is able to spread extraordinarily rapidly after initial establishment and quickly displaces native herbaceous vegetation (Barden 1987, Hunt and Zaremba 1992). The native weed *Verbesina alternifolia* (wingstem) is also abundant in the project area, especially in stand edges along the loop drive, and likely signals recent canopy disturbance and intensive, selective browsing by deer. Herbivory by deer is also reflected in the paucity of woody stems in stand understories.

All upland forest stands at Jamestown Island likely arose following the abandonment of agricultural land. Although loblolly pine was an important component of the presettlement landscape, its abundance in contemporary stands is a often a function of disturbance frequency or time since the last disturbance. This alliance comprises both natural forests that formerly experienced frequent fires of low to moderate intensity and semi-natural vegetation that develops following primarily anthropogenic disturbance. In the absence of fire, the substantial component of *Pinus taeda* is lost as a predominatly single-aged cohort senesces and conditions preclude successful regeneration.

This alliance is loosely encompassed by the concept of Acidic Oak-Hickory Forests (Fleming et al. 2001), although this ecological community group as currently circumscribed is attributed to only the mountains and Piedmont in Virginia. A new group may need to be defined to accommodate semi-natural mixed oak-pine communities of the southern Coastal Plain.

Representative Plots: 1, 2, 4, 5, 6, 7, 9

Table 5. Summary compositional data for the *Pinus taeda* - *Quercus* (*alba, falcata, stellata*) Forest Alliance. Mean cover was calculated by converting each cover class score to the midpoint value of the corresponding range of % cover, averaging the midpoints, then back-transforming the mean to cover class scores. Constancy equals the percentage of plots representing an alliance in which a given species occurs. To the right are cover class data for each plot. Values for nominal species are shown in bold font.

SPECIES	**Mean Cover**	**Constancy**	JI01	JI02	JI04	JI05	JI06	JI07	JI09
Liquidambar styraciflua	6	100	6	6	4	7	4	6	3
Pinus taeda	**6**	**86**		**2**	**7**	**5**	**7**	**6**	**1**
Quercus alba	**6**	**71**	**6**		**8**	**5**	**6**		**5**
Quercus velutina	6	57	7	7		7			6
Nyssa sylvatica	5	71	6	5	6		5	1	
Quercus stellata	**5**	**57**	**4**				**5**	**5**	**6**
Quercus falcata	**5**	**29**					**4**	**7**	
Ilex opaca var. opaca	4	86	1	6	1	5	1	2	
Carya glabra	4	29				6			4
Quercus laurifolia	4	14		6					
Quercus pagoda	4	14					6		
Cornus florida	3	14		5					
Myrica cerifera	3	14						5	
Quercus rubra	3	14				5			
Smilax bona-nox	2	100	1	1	2	2	1	1	2
Smilax rotundifolia	2	100	1	1	1	4	1	1	1
Chasmanthium laxum	2	86	2	2	3		3	2	2
Juniperus virginiana var. virginiana	2	86	1	1	2	2		1	4
Carex complanata var. hirsuta	2	57	1	1		2			1
Danthonia spicata	2	57	1		3	2			2
Dichanthelium dichotomum	2	57		1	1			1	2
Prunus serotina var. serotina	2	57		1			1	1	4
Carya alba	2	14							4
Ilex decidua	2	14		4					
Quercus x beadlei	2	14							4
Sassafras albidum	1	86		1	1	1	1	1	1
Toxicodendron radicans	1	86	1	1		1	1	1	1
Acer rubrum	1	71	1	1	1	1	1		
Microstegium vimineum	1	71	1	1	1	1	1		
Carex sp.	1	43			2	1			1
Chimaphila maculata	1	43				1	1	1	
Parthenocissus quinquefolia	1	43		1		1			1
Vitis rotundifolia	1	43		1		1			1
Dichanthelium commutatum	1	29		1					1
Andropogon virginicus	1	14						1	
Aralia spinosa	1	14				1			
Asplenium platyneuron	1	14				1			
Baptisia tinctoria	1	14						1	
Carex pensylvanica	1	14					1		
Cinna arundinacea	1	14							1
Elymus virginicus var. halophilus	1	14							2
Gaylussacia baccata	1	14						2	
Hedera helix	1	14							1
Hieracium gronovii	1	14						1	
Liriodendron tulipifera	1	14			1				
Oxalis dillenii	1	14							1
Persea palustris	1	14						1	
Pityopsis graminifolia	1	14						1	
Robinia pseudoacacia	1	14							1

Table 6. Mean density, basal area, and importance value (IV) of trees in plots representing the *Pinus taeda - Quercus* (*alba, falcata, stellata*) Forest Alliance. Units for density and basal area are number of stems·ha^{-1} and m^2·ha^{-1}, respectively. Density categories are saplings < 2.5 cm dbh (diameter at breast height), trees > 2.5 cm and < 40 cm dbh, and large trees > 40 cm dbh. Mean relative density and mean basal area are calculated as the average of values across all plots, rather than from total density and basal area values in this table, in order to portray more accurately the average expression of plots in this alliance. That is, every plot received equal weight in the computations. Importance value equals the mean of relative density and relative basal area.

SPECIES	Mean Sapling Density	Mean Tree Density	Mean Large Tree Density	MEAN TOTAL DENSITY	MEAN REL. DENSITY	MEAN BASAL AREA	MEAN REL. BASAL AREA	MEAN IV
Pinus taeda	757	64	36	857	23.33	11.220	23.98	23.66
Quercus velutina	0	29	32	61	10.97	8.316	18.44	14.71
Quercus alba	0	21	25	46	11.83	8.842	16.73	14.28
Liquidambar styraciflua	7	75	18	100	16.10	5.135	10.83	13.47
Quercus stellata	0	32	14	46	5.54	4.503	11.56	8.55
Nyssa sylvatica	0	32	4	36	10.14	2.258	4.35	7.25
Ilex opaca var. opaca	0	43	0	43	7.52	0.567	1.38	4.45
Quercus falcata	0	14	4	18	1.36	1.262	3.55	2.46
Carya glabra	0	21	0	21	3.51	0.459	1.09	2.30
Quercus laurifolia	0	0	4	4	0.65	1.185	3.05	1.85
Quercus rubra	0	0	4	4	0.60	1.297	2.00	1.30
Juniperus virginiana var. virginiana	0	14	0	14	2.25	0.139	0.30	1.27
Quercus pagoda	0	4	4	7	1.19	0.579	1.25	1.22
Carya alba	0	7	0	7	1.06	0.298	0.75	0.90
Ilex verticillata	0	7	0	7	1.30	0.018	0.05	0.67
Myrica cerifera	54	7	0	61	0.94	0.011	0.03	0.49
Prunus serotina var. serotina	0	4	0	4	0.53	0.141	0.35	0.44
Cornus florida	0	4	0	4	0.65	0.042	0.11	0.38
Quercus x beadleyi	0	4	0	4	0.53	0.084	0.21	0.37
TOTAL	**818**	**382**	**143**	**1343**	**100**	**46.355**	**100**	**100**

ALLIANCE:
***Taxodium distichum* Semipermanently Flooded Forest Alliance (A.346)**
Bald-cypress Semipermanently Flooded Forest Alliance

Formation:
Semipermanently flooded cold-deciduous forest (I.B.2.N.f.)

Composition and Physiognomy:
Low stems of *Taxodium distichum* (baldcypress) form an interrupted canopy over an herb layer patchily dominated by *Carex hyalinolepis* (shore-line sedge) (Tables 7 and 8). No other species attains > 1% cover in the single sample plot. *Pinus taeda* (loblolly pine) and *Fraxinus pennsylvanica* (green ash) are the only other species present in the overstory, but more dead than live boles are present. *Pinus* is clearly a more characteristic component of the adjacent upland forest. A few clumps of *Cephalanthus occidentalis* (buttonbush), apparently nearly senescent at the time of sampling, are present in one end of the stand. *Carex hyalinolepis*, a large, rhizomatous sedge, has a heterogeneous distribution and attains highest local cover in more open microsites outside the plot. A total of 23 species were sampled in the 400 m^2 plot.

This alliance is typically characterized by swamp forests dominated by *Taxodium distichum*, which often forms a monospecific canopy. Dominance by *Taxodium* generally exceeds 75%, but hardwoods may be present in increasing proportions where the period of inundation is shorter or the depth of flooding less. Associated canopy species include *Fraxinus profunda, Populus heterophylla,* and *Nyssa aquatica*. The subcanopy is usually sparse and may contain *Planera aquatica, Fraxinus caroliniana*, and occasionally *Acer rubrum*. As a result of the hydrologic regime, shrub and herb layers are very sparse, and species in these strata are frequently limited to tree bases, downed logs, and scattered mounds of exposed soil. Species present in these strata include *Cephalanthus occidentalis, Forestiera acuminata, Bidens discoidea, Carex lupulina, Proserpinaca palustris, Lemna minor, Azolla caroliniana,* and *Saururus cernuus*. *Lemna* spp. are very common and may be virtually the only herb taxon in some stands.

Habitat and Distribution:
Within the study area this alliance is restricted to a single isolated stand southeast of the Glass House. Extensive reconnaissance did not reveal any similar vegetation, although *Taxodium* does occur as scattered individuals in an open, disturbed, apparently tidal shrub swamp on property belonging to the Association for the Preservation of Virginia Antiquities. The hydrology of the sampled stand is uncertain. Although the occurrence is less than 20 m from the James River, a large, artificial berm separates this swamp from the river channel, and the stand bore no evidence of tidal influence. Although water depth may fluctuate tidally, it appears that surface water is constantly present. (Maximum water depth was 14 cm at the time of sampling.) The soil consists of deep, hydric sand, overlain by a shallow organic layer.

This alliance ranges from southern Delaware to southern Florida, along the lower Gulf Coastal Plain to southeastern Texas, and north along the Mississippi River Alluvial Plain to southern Illinois. It is more commonly recognized, however, outside or near the edge of the range of *Nyssa aquatica,* which frequently codominates with *Taxodium distichum* (recognized as the *Nyssa aquatica* - (*Taxodium distichum*) Semipermanently Flooded Forest Alliance [A.345]).

These areas include southwestern Arkansas and northwestern Louisiana, southeastern Oklahoma, eastern Mississippi and adjacent Alabama, southern Indiana, peninsular Florida, northeastern Virginia, eastern Maryland, and Delaware. Stands of this alliance are found in alluvial plains, ponds, lakes, and backwaters. They are typically flooded with water up to 3 m deep for part or much of the year. Water is stagnant or gently flowing. Soils are deep, poorly drained mucks or peats.

Distinguishing Features:

This vegetation is unique in the study area in its co-dominance by *Taxodium distichum* and *Carex hyalinolepis*.

Comments:
This vegetation bears gross compositional similarity to a *Carex hyalinolepis*-dominated variant of an estuarine fringe swamp forest described by Fleming and Morehead (1998) along the North Landing and Northwest Rivers in southeasternmost Virginia. This forest type, named the *Pinus taeda – Nyssa biflora – Taxodium distichum* / *Morella cerifera* / *Osmunda regalis* var. *spectabilis* Forest (in the *Pinus taeda – Nyssa biflora – Taxodium distichum* Alliance [A.1886]), may be endemic to the Albemarle-Pamlico estuary. Locally, *Carex hyalinolepis* forms dominance patches in ecotones between tidal marsh and tidal swamp forest or seasonally flooded forest in several sites in the northern Coastal Plain of Virginia. It is possible that the Jamestown Island stand represents a modified variant of the *Taxodium distichum* Tidal Woodland Alliance (A.659) in which the hydrology has been altered by the construction of the berm along the James River. This alliance reaches the northern end of its range in Virginia.

Representative Plots: 3

Table 7. Compositional data for the single plot representing the *Taxodium distichum* Semipermanently Flooded Forest Alliance. Data represent cover class scores. Values for nominal species are in bold.

SPECIES	JI03
Taxodium distichum	**7**
Carex hyalinolepis	6
Cephalanthus occidentalis	2
forb sp.	2
Fraxinus pennsylvanica	2
Panicum virgatum var. virgatum	2
Pinus taeda	2
Polygonum punctatum	2
Spartina cynosuroides	2
Acer rubrum	1
Carex sp.	1
Eupatorium capillifolium	1
Galium sp.	1
Hydrocotyle verticillata var. verticillata	1
Juncus sp.	1
Ludwigia palustris	1
Peltandra virginica	1
Pilea fontana	1
Rumex verticillatus	1
Thelypteris palustris var. pubescens	1
Toxicodendron radicans	1
Vitis rotundifolia	1

Table 8. Density, basal area, and importance value of trees in the single plot representing the *Taxodium distichum* Semipermanently Flooded Forest Alliance. For details see Table 4.

SPECIES	Mean Sapling Density	Mean Tree Density	Mean Large Tree Density	MEAN TOTAL DENSITY	MEAN REL. DENSITY	MEAN BASAL AREA	MEAN REL. BASAL AREA	MEAN IV
Taxodium distichum	50	875	0	925	92.50	16.303	96.49	94.49
Fraxinus pennsylvanica	0	25	0	25	2.50	0.588	3.48	2.99
Cephalanthus occidentalis	50	0	0	50	5.00	0.006	0.03	2.52
TOTAL	**100**	**900**	**0**	**1000**	**100**	**16.896**	**100**	**100**

ALLIANCE:
***Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance (A.323)**
(Water Tupelo, Swamp Blackgum, Ogeechee Tupelo) Floodplain Seasonally Flooded Forest Alliance

Formation:
Seasonally flooded cold-deciduous forest (I.B.2.N.e.)

Composition and Physiognomy:
Acer rubrum (red maple) and *Pinus taeda* (loblolly pine) form an open canopy over a well-developed herb layer overwhelmingly dominated by *Carex hyalinolepis* (shore-line sedge) (Tables 9 and 10). *Liquidambar styraciflua* (sweetgum), present outside the single sample plot, contributes cover and represents the only other species in the overstory. *Acer* attains higher cover in the subcanopy, where snags abound. Shrubs are sparse but patchy; *Persea palustris* (red bay) and *Morella* (= *Myrica cerifera*) (common wax-myrtle) are present but more abundant in the adjacent upland forest of subtly higher elevation. Herbaceous richness is surprisingly high, given the robustness and cover of the perennial sedge *Carex hyalinolepis*. *Polygonum arifolium* (halberd-leaf tearthumb), *Thelypteris palustris* var. *pubescens* (marsh fern), *Leersia virginica* (Virginia cutgrass), and *Mikania scandens* climbing hempweed) all attain > 1% cover. A total of 23 species were sampled in the 400 m^2 plot.

This vegetation is assigned to the *Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance based on compositional and hydrologic similarity to one of the alliance's constituent associations, the *Nyssa biflora - Liquidambar styraciflua* / *Glyceria septentrionalis - Hydrocotyle ranunculoides* Forest. Fleming and Moorhead (1998) described this community type from the Northwest and North Landing Rivers in southeasternmost Virginia, where it occurs generally in supratidal positions along the upland borders of backswamps and small tributary swamps. The canopy composition of this unit varies from nearly pure stands of *Nyssa biflora* to mixed stands of *Nyssa biflora, Liquidambar styraciflua, Acer rubrum,* and *Quercus laurifolia*. Characteristic subcanopy trees include all of the canopy species, along with *Magnolia virginiana, Ilex opaca,* and *Ulmus americana*. Vines, especially *Decumaria barbara* and *Toxicodendron radicans*, are common. Characteristic shrubs are *Lyonia ligustrina var. foliosiflora, Magnolia virginiana, Morella cerifera* (*= Myrica cerifera*), *Persea palustris, Rosa palustris*, and *Vaccinium formosum*. Large colonies of the nominal herbs *Glyceria septentrionalis* and *Hydrocotyle ranunculoides* often dominate the seasonal aspect of drawdown habitats. Additional herbs which are locally abundant in early or late-seasonal drawdown zones include *Bidens discoidea, Carex joorii, Hydrolea quadrivalvis, Ludwigia palustris, Orontium aquaticum, Polygonum densiflorum, Ranunculus sceleratus, Rumex verticillatus, Woodwardia virginica,* and the exotic *Alternanthera philoxeroides*. *Limnobium spongia* occasionally dominates the most deeply flooded backswamp microhabitats. Other, more-or-less constant and characteristic herbs of this vegetation include *Carex atlantica ssp. capillacea, Carex hyalinolepis, Carex seorsa, Cicuta maculata, Osmunda regalis var. spectabilis, Polygonum arifolium, Ptilimnium capillaceum,* and *Saururus cernuus*.

In the typical expression of this alliance, stands are dominated by one or more species of tupelo (*Nyssa aquatica, N. biflora*, or *N. ogeche*) without substantial *Taxodium distichum*. *Acer rubrum*

var. rubrum, Quercus laurifolia, Quercus lyrata, Ulmus americana, and *Liquidambar styraciflua* are other characteristic canopy species. Some examples may include *Fraxinus pennsylvanica, Ilex opaca,* and *Magnolia virginiana*. The canopy layer in these forests often is dense, but lower strata are sparse to very sparse. *Fraxinus caroliniana, Itea virginica, Ulmus americana,* and *Sebastiania fruticosa* are common understory species. Characteristic shrubs include *Ilex verticillata, Itea virginica, Leucothoe axillaris, Leucothoe racemosa, Lyonia ligustrina var. foliosiflora, Lyonia lucida, Morella cerifera* (= *Myrica cerifera*), *Persea palustris,* and *Clethra alnifolia.* Common herbaceous species are *Boehmeria cylindrica, Carex gigantea, Carex seorsa, Carex stipata var. maxima, Commelina virginica, Dulichium arundinaceum, Peltandra virginica, Phanopyrum gymnocarpon* (= *Panicum gymnocarpon*), *Pluchea* sp., *Carex bromoides, Rhynchospora corniculata, Leersia lenticularis, Justicia ovata, Proserpinaca pectinata, Saururus cernuus, Osmunda regalis var. spectabilis, Woodwardia areolata,* and *Pleopeltis polypodioides.*

Habitat and Distribution:
The single sampled stand is located proximate to tidal marsh vegetation along Kingsmill Creek and is separated from the marsh by a narrow band of tidal shrub swamp. The hydrologic regime appears to be non-tidal, although the water table may fluctuate tidally. During field sampling, the water table was encountered at a depth of 15 cm. A second example of palustrine forest vegetation in the project area was identified along the northern boundary, just north of the Colonial Parkway. This stand, which was also dominated by *Acer rubrum,* was not quantitatively sampled and is very tentatively assigned to this alliance. The hydrology of this site is also uncertain; a channel running through the center of the stand appears to be tidally influenced, but there is no evidence of extensive interior flooding.

The hydrology of the *Nyssa biflora - Liquidambar styraciflua* / *Glyceria septentrionalis - Hydrocotyle ranunculoides* Forest is seasonally to less often semipermanently flooded. Some habitats occupied by this type are substantially drawn down by late May or early June; others have a more prolonged flooding regime, and local areas retain shallow water in hollows or pools throughout most or all of the growing season. Some habitats are rarely or occasionally flooded by exceptionally high wind tides. This particular association is known only from Virginia and possibly North Carolina.

Forests in this alliance occur in seasonally flooded floodplains, sloughs, and backswamps. These habitats include seasonally flooded low areas along small streams with intermittent flow in regions of very subdued topographic relief. The alliance ranges along the Atlantic Coastal Plain from southern Virginia to Florida and along the Gulf Coastal Plain to eastern Texas.

Distinguishing Features:
This vegetation type comprises a broadly defined set of palustrine forest types of uncertain (but apparently non-tidal) hydrology. Upland oak species are absent.

Comments:
Fleming and Moorhead (1998) noted that occasional stands dominated almost exclusively by *Liquidambar styraciflua* and *Acer rubrum* may represent an early seral stage following severe logging. One stand on the North Landing River, immediately adjacent to an upland edge,

contains abundant *Carex hyalinolepis* and is characterized by a shallow water table. The satisfactory assignment of this plot to an alliance in the USNVC proved problematic, but the crosswalk was accepted because of the similarity to the *Nyssa biflora - Liquidambar styraciflua* / *Glyceria septentrionalis - Hydrocotyle ranunculoides* Forest. The proper placement of this association in the USNVC hierarchy warrants further scrutiny.

Representative Plots: 17

Table 9. Compositional data for the single plot representing the *Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance. Data represent cover class scores. Values for nominal species are in bold.

SPECIES	JI17
Carex hyalinolepis	9
Acer rubrum	6
Pinus taeda	4
Polygonum arifolium	4
Thelypteris palustris var. pubescens	4
Leersia virginica	3
Liquidambar styraciflua	3
Mikania scandens	3
Myrica cerifera	3
Persea palustris	3
Chasmanthium laxum	2
Cinna arundinacea	2
Elymus virginicus var. halophilus	2
Hydrocotyle verticillata var. verticillata	2
Panicum virgatum var. virgatum	2
Polygonum punctatum	2
Teucrium canadense	2
Toxicodendron radicans	2
Baccharis halimifolia	1
Cornus foemina	1
Dichanthelium dichotomum	1
Smilax rotundifolia	1
Vitis rotundifolia	1

Table 10. Density, basal area, and importance value of trees in the single plot representing the *Nyssa* (*aquatica, biflora, ogeche*) Floodplain Seasonally Flooded Forest Alliance. For details see Table 4. Density and basal area for dead *Acer rubrum* were not included in the totals used to calculate relative values.

SPECIES	Mean Sapling Density	Mean Tree Density	Mean Large Tree Density	MEAN TOTAL DENSITY	MEAN REL. DENSITY	MEAN BASAL AREA	MEAN REL. BASAL AREA	MEAN IV
Acer rubrum	0	300	50	350	58.33	19.747	78.62	68.48
Myrica cerifera	125	50	0	175	29.17	0.055	0.22	14.69
Pinus taeda	0	0	25	25	4.17	5.309	21.14	12.65
Persea palustris	50	0	0	50	8.33	0.006	0.02	4.18
(dead Acer rubrum)	0	225	0	225		7.959		
TOTAL	**175**	**350**	**75**	**600**	**100**	**25.117**	**100**	**100**

ALLIANCE:
***Peltandra virginica – Pontederia cordata* Tidal Herbaceous Alliance (A.1703)**
Green Arrow-arum - Pickerelweed Tidal Herbaceous Alliance

Formation:
Tidal temperate perennial forb vegetation (V.B.2.N.g.)

Composition and Physiognomy:
Composition dominance vary considerably, and *Peltandra virginica* (arrow-arum) is the only constant species (Table 11). This vegetation type includes low-stature marshes dominated or co-dominated by *Peltandra*, as well as taller vegetation in which *Peltandra* is a relatively minor component. Other species dominant in one or more stands comprise *Schoenoplectus pungens* (common three-square), *S. tabernaemontani* (soft-stem bulrush), *S. americana* (Olney threesquare), *Zizania aquatica* var. *aquatica* (wild rice), and *Polygonum punctatum* (dotted smartweed). Less abundant but frequent associates include *Spartina cynosuroides* (giant cordgrass), *Echinochloa walteri* (Walter's barnyard grass), and *Rumex verticillatus* (swamp dock). Species richness ranges from 2 to 13 taxa · 100 m^{-2}, with a mean of 8.

This alliance is very broadly defined and encompasses a compositionally wide range of freshwater tidal marshes generally characterized by low positions in the intertidal zone and a lack of tall (> 1m) perennial graminoids or forbs. Typical stands are dominated by variable mixtures of *Peltandra virginica* and *Pontederia cordata*, although the former is much more characteristic of Virginia occurrences. Other species present can include *Bidens* spp., *Zizania aquatica, Sagittaria* spp., *Acorus americanus*, and *Polygonum* spp.

Preliminary analysis of tidal marsh vegetation throughout Virginia suggests that the *Peltandra*-dominated marshes at Jamestown Island include two distinct community types, which sort out along a halinity gradient. The *Peltandra virginica* [provisional] Tidal Oligohaline Marsh has also been documented from the Chickahominy and Pamunkey Rivers. In the project area this community type is known from Back River, which apparently is characterized by somewhat less brackish conditions than the marshes of the Kingsmill and Passmore Creek drainages. Species richness is notably low, averaging only 4 taxa·100 m^{-2}. Other than *Peltandra, Zizania* is the only species present in more than half of the 11 plots supporting this type. The second community type, the *Peltandra virginica – Echinochloa walteri – Schoenoplectus* (*pungens, tabernaemontani*) Tidal Oligohaline Marsh [provisional], generally supports higher species richness (mean = 9 species·100 m^{-2} and contains several taxa typically associated with oligohaline conditions, including *Echinochloa walteri, Rumex verticillatus,* and *Pluchea odorata* (saltmarsh fleabane). Examples have been documented from Back River and Passmore Creek drainages.

Habitat and Distribution:
At Jamestown Island this alliance occurs in isolated, somewhat fresh pockets of open water or low, vegetated mudflats or along second-order tributaries in the interior of extensive marshes. Throughout its range, which extends from Maine to Virginia, this alliance occurs primarily in low portions of the intertidal zone, on mucky substrates.

Distinguishing Features:
This vegetation type can be distinguished from other tidal marsh communities in the project area by its general absence of tall graminoids, relatively low species richness, and position in the low intertidal zone.

Comments:
The *Peltandra virginica – Pontederia cordata* Tidal Herbaceous Vegetation (G3G4) in the USNVC ranges from Maine to Virginia (excepting New Hampshire and Rhode Island). Because this association is so broadly defined, it is not possible to determine whether either of the preliminary *Peltandra* community types described above represents a variant of this vegetation type or distinct associations. Hence the assignment of G-ranks is premature. Both community types may be uncommon to rare in Virginia.

Walton et al. (2001) classified similar vegetation on the Pamunkey River as the *Peltandra virginica – Eleocharis parvula – Sagittaria subulata* Oligohaline Tidal Mudflat community type and assigned it a tentative state conservation rank of S3?. This type is reported from oligohaline mudflats in the interior portion of oligohaline marshes away from the main channel. Such microsites may accumulate pockets of freshwater because they do not flush completely with every tidal cycle.

Representative Plots: 8, 11, 13, 14, 18, 19

Peltandra virginica Tidal Freshwater Marsh: 11, 19

Peltandra virginica – Echinochloa walteri – Schoenoplectus (*pungens*, *tabernaemontani*) Tidal Oligohaline Marsh: 8, 13, 14, 18

Table 11. Summary compositional data for the *Peltandra virginica - Pontederia cordata* Tidal Herbaceous Alliance. For details see Table 4.

SPECIES	Mean Cover	Constancy	JI08	JI11	JI13	JI14	JI18	JI19
Peltandra virginica	**6**	**100**	**2**	**7**	**3**	**3**	**6**	**8**
Zizania aquatica var. aquatica	6	83	1	1	7		7	5
Schoenoplectus pungens	6	67	7	5		7	7	
Schoenoplectus tabernaemontani	5	67	3		6	5	4	
Polygonum punctatum	4	50	6		5	1		
Spartina cynosuroides	4	50	5		5		2	
Schoenoplectus americanus	4	17			6			
Eleocharis rostellata	3	17				5		
Echinochloa walteri	2	50			4	2	2	
Rumex verticillatus	2	50	1		1		2	
Amaranthus cannabinus	2	33	2		1			
Eleocharis palustris	2	33	4	2				
Pluchea odorata	2	33	3		3			
Sagittaria lancifolia	2	33			3		3	
Leersia oryzoides	2	17	3					
Cinna arundinacea	1	17	1					
Pontederia cordata	**1**	**17**	**2**					
Sagittaria subulata	1	17		1				
Schoenoplectus robustus	1	17				2		

ALLIANCE:
***Schoenoplectus americanus* Tidal Herbaceous Alliance (A.2007)**
Chairmaker's Bulrush Tidal Herbaceous Alliance

Formation:
Tidal temperate or subpolar grassland (V.A.5.N.n.)

Composition and Physiognomy:
Schoenoplectus americanus (= *Scirpus americanus = S. olneyi*; Olney threesquare) is the principal dominant species (Table 12). Characteristic associates include *Spartina patens* (saltmeadow cordgrass), *Distichlis spicata* (saltgrass), *Polygonum punctatum* (dotted smartweed), *Typha angustifolia* (narrow-leaved cattail), and *Panicum virgatum* var. *virgatum* (switchgrass). *Cyperus filicinus* (a flatsedge) attains moderately high cover in one plot. This same stand contains scattered clumps of robust *Setaria magna* (giant foxtail), a grass characteristic of Atlantic coastal marshes, but not previously sampled in a large set of tidal marsh plots in Virginia. Species richness is strikingly high, with a mean of 21 taxa in each of the two sampled 100 m^2 plots.

This alliance includes tidal mesohaline to oligohaline marshes dominated or codominated by *Schoenoplectus americanus*. Other associated species can include *Spartina patens, Spartina alterniflora, Spartina cynosuroides, Phragmites australis, Juncus roemerianus,* and *Typha* spp. *Schoenoplectus americanus* is often the visual dominant with scattered individuals and patches of *Typha domingensis* or *Juncus roemerianus*. *Spartina patens* may also be present and may even codominate occurrences in some associations.

Habitat and Distribution:
At Jamestown Island this vegetation is known from two locations in the upper section of the Kingsmill Creek drainage, near the loop drive. The substrate of one stand was a typical hydric, mucky clay, with abundant rhizome material. The other (plot 16) is characterized by an unusual floating mat of partially decomposed organic matter, fine roots, and *Schoenoplectus* rhizomes and organic soil to a depth of > 40 cm. Such a substrate had not previously been documented from any tidal marsh in Virginia. Based on their position in the landscape, both stands are believed to experience oligohaline conditions, although the presence of the halophytes *Spartina patens* and *Distichlis spicata* suggests higher halinity.

This alliance occupies low-gradient marshes that are influenced by irregular pulses of both brackish and fresh water. Halinity is thought to range from mesohaline to oligohaline. This alliance is known from the Gulf Coast of Texas, the Chenier Plain of Louisiana, and the mid-Atlantic coast of Virginia, Maryland and Delaware; it may also occur along the Gulf Coast of Mississippi and Alabama and possibly along the lower Atlantic coast of the United States.

Distinguishing Features:
Among Jamestown Island tidal marsh vegetation types, this alliance supports the highest mean species richness, the largest number of typically mesohaline species, and the greatest abundance of *Schoenoplectus americanus*.

Comments:
This vegetation bears remarkable similarity to wind-tidal marshes documented from Back Bay in Virginia and to diurnally tidal marshes along tributaries of the Great Wicomico and Potomac Rivers on the Northern Neck of Virginia. These stands have been provisionally classified as the *Spartina patens – Schoenoplectus americanus –* (*Eleocharis parvula, fallax*) Tidal Oligohaline Marsh community type. *Spartina patens* and *Schoenoplectus americanus* are constant constituents, although in most stands only one of these two species dominates. Other characteristic and abundant species include *Polygonum punctatum, Sagittaria lancifolia* (bull-tongue arrowhead), *Typha angustifolia, Hibiscus moscheutos* ssp. *moscheutos* eastern rose-mallow), and *Kosteletzkya virginica* (Virginia seashore mallow). *Eleocharis parvula* (small spikerush) or *E. fallax* (creeping spikerush) is frequently a codominant species. Richness averages 15 species·100 m^{-2}. This community type corresponds well to the *Schoenoplectus americanus – Spartina patens* Herbaceous Vegetation in the USNVC. Although this vegetation has not been assigned a global conservation rank, it has been attributed only to Delaware and Maryland and, except for the putative occurrences at Back Bay, may be chiefly restricted to the Chesapeake Lowlands ecoregion, which is roughly bounded by the James and Potomac Rivers.

Dominance patterns in associations within this alliance are not well understood, but are likely related to gradients in halinity and hydrology. *Schoenoplectus americanus* appears to dominate in areas with higher average water level, lower halinity, and lower frequency of flooding than areas typically dominated by *Spartina patens*.

The occurrence of this alliance and putative globally rare community type constituted the principal reason for recognizing a significant community element at Jamestown Island (see Chazal et al. 2002). Because DCR-DNH currently classifies communities statewide at the ecological community group level (see INTRODUCTION, *United States National Vegetation Classification*), a single Tidal Oligohaline Marsh element occurrence record was defined, which encompasses most of the tidal marshes present in the project area. An existing conservation site, Jamestown Island Marshes, was modified to enclose this element occurrence entirely.

Representative Plots: 15, 16

Table 12. Summary compositional data for the *Schoenoplectus americanus* Tidal Herbaceous Alliance. For details see Table 4.

SPECIES	Mean Cover	Constancy	JI15	JI16
Schoenoplectus americanus	**8**	**100**	**7**	**8**
Cyperus filicinus	5	50		6
Distichlis spicata	4	100	4	2
Polygonum punctatum	4	100	5	3
Spartina patens	4	100	5	3
Typha angustifolia	4	100	4	2
Leersia oryzoides	4	50	5	
Thelypteris palustris var. pubescens	4	50		5
Panicum virgatum var. virgatum	3	100	3	3
Eleocharis parvula	3	50		4
Eleocharis rostellata	3	50	4	
Sagittaria lancifolia	3	50	4	
Amaranthus cannabinus	2	100	2	1
Cyperus odoratus	2	100	1	3
Hibiscus moscheutos ssp. moscheutos	2	100	1	2
Kosteletzkya virginica	2	100	1	2
Boehmeria cylindrica	2	50		2
Cicuta maculata var. maculata	2	50	2	
Echinochloa walteri	2	50		2
Eleocharis palustris	2	50		2
Pluchea odorata	2	50		3
Rumex verticillatus	2	50		2
Setaria magna	2	50		3
Solidago sempervirens var. mexicana	2	50	2	
Symphiotrichum novi-belgii	2	50	2	
Symphiotrichum subulatum	2	50	2	
Typha x glauca	2	50	2	
Cinna arundinacea	1	50	1	
Hydrocotyle verticillata var. verticillata	1	50		1
Lythrum lineare	1	50	1	
Peltandra virginica	1	50	1	

ALLIANCE:
***Spartina cynosuroides* Tidal Herbaceous Alliance (A.1480)**
Giant Cordgrass Tidal Herbaceous Alliance

Formation:
Tidal temperate or subpolar grassland (V.A.5.N.n.)

Composition and Physiognomy:
The vegetation is dominated by dense, robust culms of *Spartina cynosuroides* (giant cordgrass), in combination with *Hibiscus moscheutos* ssp. *moscheutos* (eastern rose-mallow), *Schoenoplectus robustus* (saltmarsh bulrush), *Polygonum punctatum* (dotted smartweed), and *Leersia oryzoides* (rice cutgrass) (Table 13). Although extensive stands appear from a distance to represent near monocultures of *Spartina*, several additional species attain nearly as high cover, especially in the interior of stands. *Spartina* dominance is generally greatest on the narrow, elevated margins of tidal channels. Stems of *Spartina* may exceed 3 m in height. Eleven species were sampled in the one representative plot.

Rangewide this alliance is similar to the stand sampled at Jamestown Island. Other associated species include *Schoenoplectus pungens, Schoenoplectus tabernaemontani, Pontederia cordata, Peltandra virginica, Typha domingensis,* and *Typha angustifolia*.

Habitat and Distribution:
Spartina cynosuroides forms extensive stands in the marshes along the tributaries of Passmore Creek. Dense culms of this perennial grass likely act as effective sediment traps, which may reinforce the slightly elevated levees along tidal channels with which *Spartina* is strongly associated. This species is a faithful indicator of oligohaline conditions. The alliance ranges from Connecticut to Georgia but is most extensive in mid-Atlantic states.

Distinguishing Features:
This alliance shares many species with the *Typha* (*angustifolia, domingensis*) Tidal Herbaceous Alliance. Diagnostic characteristics are vegetation stature approaching or exceeding 3 m and dominance by *Spartina cynosuroides.*

Comments:
Vegetation at Jamestown Island is compositionally similar to other relatively diverse tidal oligohaline marshes in Virginia in which *Spartina cynosuroides* and *Polygonum punctatum* are the only constant and consistently abundant species. Other characteristic but less frequent taxa comprise *Hibiscus moscheutos* ssp. *moscheutos, Kosteletzkya virginica* (Virginia seashore mallow), *Amaranthus cannabinus* (water-hemp), *Peltandra virginica* (arrow-arum), and *Pluchea odorata* (saltmarsh fleabane). Representative samples of the *Spartina cynosuroides – Kosteletzkya virginica* Tidal Oligohaline Marsh [provisional] on the Pamunkey River were classified as the *Kosteletzkya virginica* Mixed Oligohaline Marsh (S2?) by Walton et al. (2001). This community type, which has been documented from numerous drainages in the state, differs from significantly more depauperate *Spartina cynosuroides*-dominated vegetation that appears to be restricted to riverine tidal marshes along the Mattaponi and Pamunkey Rivers.

Two *Spartina cynosuroides* associations have been described in the USNVC: *Spartina cynosuroides – Panicum virgatum – Phyla lanceolata* Herbaceous Vegetation (G2G3/S2S3; Fleming and Moorhead 1998) of wind-tidal oligohaline marshes of southeastern Virginia and possibly northeastern North Carolina, and more broadly defined *Spartina cynosuroides* Herbaceous Vegetation (G4), which essentially constitutes a placeholder for further associations to be defined in the *Spartina cynosuroides* Tidal Herbaceous Alliance. This latter association does not adequately encompass the range of variation in *Spartina cynosuroides* vegetation in Virginia.

Representative Plots: 10

Table 13. Compositional data for the single plot representing the *Spartina cynosuroides* Tidal Herbaceous Alliance. Data represent cover class scores. Values for nominal species are in bold.

SPECIES	JI10
Spartina cynosuroides	**7**
Hibiscus moscheutos ssp. moscheutos	6
Polygonum punctatum	6
Schoenoplectus robustus	6
Leersia oryzoides	5
Peltandra virginica	3
Pluchea odorata	2
Schoenoplectus tabernaemontani	2
Amaranthus cannabinus	1
Rumex verticillatus	1
Sagittaria lancifolia	1

ALLIANCE:
***Typha* (*angustifolia, domingensis*) Tidal Herbaceous Alliance (A.1472)**
(Narrowleaf Cattail, Southern Cattail) Tidal Herbaceous Alliance

Formation:
Tidal temperate or subpolar grassland (V.A.5.N.n.)

Composition and Physiognomy:
Vegetation is composed of dense culms of *Typha angustifolia* (narrow-leaved cattail), often with *Schoenoplectus robustus* (saltmarsh bulrush) as a subdominant species (Table 14). No other species attains > 1% cover. Other constituents comprise *Hibiscus moscheutos* ssp. *moscheutos* (eastern rose-mallow), *Kosteletzkya virginica* (Virginia seashore mallow), *Peltandra virginica* (arrow-arum), *Polygonum punctatum* (dotted smartweed), *Schoenoplectus tabernaemontani* (softstem bulrush), and *Spartina cynosuroides* (giant cordgrass). A total of eight species were sampled in the single representative plot.

This alliance encompasses tidal marshes dominated by *Typha angustifolia* or *Typha domingensis*. Examples of this alliance are composed of a mixture of brackish and freshwater tidal species. Associate species include *Spartina cynosuroides, Phragmites australis, Schoenoplectus americanus, Pontederia cordata, Lilaeopsis chinensis, Hibiscus moscheutos, Pluchea odorata, Spartina patens, Distichlis spicata, Schoenoplectus pungens, Lycopus americanus, Eleocharis palustris, Hydrocotyle umbellata, Eupatorium capillifolium, Ptilimnium capillaceum, Bidens* spp., and *Spartina alterniflora*. Alabama and Texas communities are dominated by the more southern cattail species *Typha domingensis*.

Habitat and Distribution:
This alliance occurs in small patches near tributaries of Passmore Creek, proximate to both more diverse, less brackish marsh and linear patches dominated by *Spartina cynosuroides*. *Typha* also dominates extensive stands in the interior of the project area, along the upper reaches of the Kingsmill Creek drainage. The alliance occurs along the Atlantic coast from Maine through South Carolina and along the Gulf coast in Alabama and Texas.

Distinguishing Features:
Although composition may vary widely, this alliance is readily identifiable by the strong dominance by *Typha angustifolia* or *T. domingensis*. Both species are common components of tidal oligohaline marshes, but this is the only vegetation type in which either attains cover > 50%.

Comments:
This vegetation type is widespread but relatively undersampled in Virginia. A preliminary statewide analysis revealed a distinct but compositionally heterogeneous group, which has been named the *Typha angustifolia* Tidal Oligohaline Marsh (S4?; Fleming and Moorhead 1998). In addition to *Typha*, only *Polygonum punctatum, Hibiscus moscheutos* ssp. *moscheutos, Peltandra punctatum,* and *Schoenoplectus robustus* occur in at least half of the six representative plots. Nearly identical vegetation occurs in non-tidal maritime habitats subjected to seasonal or occasional overwash flooding.

The single USNVC association that has been described for this alliance along the Atlantic Coast is the *Typha angustifolia – Hibiscus moscheutos* Herbaceous Vegetation (G?), which ranges from Maine south to Virginia and possibly the Carolinas.

There is evidence to suggest that *Typha angustifolia* has increased in abundance and extent in recent years in some wind-tidal oligohaline marshes in southeastern Virginia (Fleming and Moorhead 1998). Potential reasons for this expansion include eutrophication, hydrologic modification, and exclusion of wildfire.

Representative Plots: 12

Table 14. Compositional data for the single plot representing the *Typha* (*angustifolia, domingensis*) Tidal Herbaceous Alliance. Data represent cover class scores. Values for nominal species are in bold.

SPECIES	JI12
Typha angustifolia	**8**
Schoenoplectus robustus	6
Hibiscus moscheutos ssp. moscheutos	1
Kosteletzkya virginica	1
Peltandra virginica	1
Polygonum punctatum	1
Schoenoplectus tabernaemontani	1
Spartina cynosuroides	1

ALLIANCE:
***Phragmites australis* Tidal Herbaceous Alliance (A.1477)**
Common Reed Tidal Herbaceous Alliance

Formation:
Tidal temperate or subpolar grassland (V.A.5.N.n.)

Composition and Physiognomy:
Species composition varies from near monocultures of *Phragmites australis* (common reed) to surprisingly high diversity of low-cover associate species, but strong dominance by *Phragmites* characterizes all stands. Most contemporary occurrences are considered invasive and non-indigenous, but putatively native stands have been documented. Culms of *Phragmites* are often extraordinarily dense and robust, frequently reaching heights of 4-5 m. No single other species occurs consistently enough to be considered characteristic; other taxa that may be present include *Morella cerifera* (= *Myrica cerifera*), *Kosteletzkya virginica, Calystegia sepium, Boehmeria cylindrica, Typha angustifolia, Apocynum cannabinum, Rosa palustris, Polygonum* sp., *Mikania scandens*, and *Toxocodendron radicans*. Supposedly native occurrences may contain *Sagittaria platyphylla, Spartina alterniflora, Schoenoplectus americanus, Vigna luteola,* and *Typha* spp. This vegetation type was not quantitatively sampled in the project area.

Habitat and Distribution:
Stands at Jamestown Island were observed in marshes along Back River, Passmore Creek, and Powhatan Creek. This alliance is found in fresh to brackish tidal marshes along the Gulf and Atlantic coasts of the United States, ranging from Maine and likely the maritime provinces of Canada south to Florida and west to Texas.

Distinguishing Features:
All communities dominated by *Phragmites australis* are classified as this vegetation type.

Comments:
Although *Phragmites australis* rhizomes have been identified in salt marsh sediments exceeding 3000 years in age, and thus the species must be considered a native component of the vegetation of at least some portion of eastern North America, the growth habit of the species in its native condition was likely very different than that of the dense, monotypic, invasive stands circumscribed by this alliance. Recent molecular evidence (Saltonstall 2002) indicates that a cosmopolitan haplotype of *Phragmites*, which is also found in Europe and Asia, has replaced a number of native haplotypes since the early 20th century. (The erstwhile predominant native haplotype of eastern North America apparently continues to persist in isolated sites, including one along the Rappahannock River in Virginia.) This new genotype, coupled with increases in the frequency and intensity of anthropogenic disturbance in coastal habitats and the potential for rapid spreading by asexual reproduction, may explain the heightened invasiveness of this species. Establishment of dominance patches of *Phragmites* is facilitated by both direct habitat alteration and the local availability of propagules.

The compositional variation of stands in this alliance reflects the range of native vegetation types that have presumably been converted by invasion of *Phragmites*. The *Phragmites australis* Tidal

Herbaceous Vegetation in the USNVC has assigned a global conservation rank of GW, to reflect the ruderal nature of this vegetation and dominance by an effectively non-native species. This association is equivalent to the Virginia community type, *Phragmites australis* Tidal Disturbed Marsh (SW).

Evidence suggests that the Gulf Coastal Plain continues to support a native haplotype which also occurs in South America (Saltonstall 2002). *Phragmites* is also an aggressive invader of non-tidal wetland habitats.

ALLIANCE:
***Zizania aquatica* Tidal Herbaceous Alliance (A.1484)**
Indian Wild Rice Tidal Herbaceous Alliance

Formation:
Tidal temperate or subpolar grassland (V.A.5.N.n.)

Composition and Physiognomy:
This alliance is characterized by tidal freshwater marshes in which *Zizania aquatica* var. *aquatica* (wild rice) dominates or codominates with other graminoids such as *Typha angustifolia, Schoenoplectus fluviatilis (= Scirpus fluviatilis),* and *Sparganium eurycarpum*. Other characteristic species include *Sagittaria latifolia, Leersia oryzoides, Amaranthus cannabinus, Impatiens capensis, Bidens* spp., *Acorus calamus,* and *Echinochloa walteri*.

Habitat and Distribution:
These marshes typically occur along tidal river systems (in shallow bays, shoals, or at the mouth of channels) under tidal influence but generally exposed to predominantly freshwater conditions. Soils are highly variable and are composed of varying amounts of silts, silty mucks, very coarse sands, and fine peat. Communities of this alliance occur from Maine south to North Carolina and possibly Florida and west to Louisiana.

Distinguishing Features:
This alliance can be distinguished from other tidal marsh vegetation in the project area by the combination of dominance by tall graminoids and the prevalence of species with freshwater affinities.

Comments:
In Virginia marshes dominated by *Zizania aquatica* var. *aquatica* are widespread and have been particularly well documented along the Mattaponi and Pamunkey Rivers. Cluster analysis suggests three distinct community types: (a) the *Zizania aquatica* var. *aquatica – Impatiens capensis – Polygonum sagittatum –* (*Bidens laevis, coronata*) Tidal Freshwater Marsh, (b) the *Zizania aquatica* var. *aquatica – Leersia oryzoides* Tidal Freshwater Marsh, and (c) the *Zizania aquatica* var. *aquatica – Polygonum punctatum* Tidal Freshwater Marsh. These community types appear to segregate along a halinity gradient and a parallel gradient in species richness. State conservation ranks for these communities have not been developed. Without quantitative data it cannot be determined which of these types the *Zizania* marshes at Jamestown Island represent.

The *Zizania aquatica* Tidal Herbaceous Vegetation (G4?) is the sole association defined for this alliance.

LITERATURE CITED

Anderson, M., P. Bourgeron, M. T. Bryer, R. Crawford, L. Engelking, D. Faber-Langendoen, M. Gallyoun, K. Goodin, D. H. Grossman, S. Landaal, K. Metzler, K. D. Patterson, M. Pyne, M. Reid, L. Sneddon, and A. S. Weakley. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume II. The national vegetation classification system: list of types. The Nature Conservancy, Arlington, VA. 502 pp.

Bray, J. R., and J. T. Curtis. 1957. An ordination of the upland forest communities of southern Wisconsin. Ecological Monographs 27: 325-349.

Chazal, A. C. and N. E. Van Alstine. 2001. An inventory for rare, threatened, and endangered species in the Jamestown Island 400 Project Area, Colonial National Historical Park. Natural Heritage Technical Report 01-23. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond, Virginia. Unpublished report submitted to Colonial National Historical Park. 40 pages plus appendices.

Curtis, J. T. 1959. The vegetation of Wisconsin: an ordination of plant communities. University of Wisconsin Press, Madison, WI. 657 pp.

Environmental Systems Research Institute, Inc. 1992-1999. ArcView GIS. Version 3.2. ESRI, Redlands, CA.

Fenneman, N.M. 1938. Physiography of eastern United States. McGraw-Hill, New York.

Fleming, G. P., P. P. Coulling, D. P. Walton, K. M. McCoy, and M. R. Parrish. 2001. The natural communities of Virginia: classification of ecological community groups. First approximation. Natural Heritage Technical Report 01-1. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 76 pp.

Fleming, G. P., and W. H. Moorhead III. 1998. Comparative wetlands ecology study of the Great Dismal Swamp, Northwest River, and North Landing River in Virginia. Natural Heritage Tech. Rep. 98-9. Virginia Deptartment of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the U.S. Environmental Protection Agency. 181 pp. plus appendices.

Grossman, D. H., D. Faber-Landendoen, A. S. Weakley, M. Anderson, P. Bourgeron, R. Crawford, K. Goodin, S. Landaal, K. Metzler, K. Patterson, M. Pyne, M. Reid, and L. Sneddon. 1998. International classification of ecological communities: terrestrial vegetation of the United States. Volume I. The national vegetation classification system: development, status, and applications. The Nature Conservancy, Arlington, VA. 126 pp.

Hodges, R.L., P. B. Sabo, D. McCloy, and C. K. Staples. 1985. Soil survey of James City and York Counties and the City of Williamsburg, Virginia. USDA Soil Conservation Service.

Kartesz, J. A. 1999. A synonymized checklist and atlas with biological attributes for the vascular flora of the United States, Canada, and Greenland. First Edition. *in* Kartesz, J. T., and C. A. Meacham. 1999. Synthesis of the North American Flora, Version 1.0. North Carolina Botanical Garden, Chapel Hill, NC.

Lance, G. N., and W. T. Williams. 1966. A generalized sorting strategy for computer classifications. Nature 212: 218.

Lance, G. N., and W. T. Williams. 1967. A general theory of classification sorting strategies. I. Hierarchical systems. Computer Journal 9: 373-380.

McCune, B., and M. J. Mefford. 1997. PC-ORD. Multivariate analysis of ecological data. Version 3.0, updated to 3.18. MjM Software Design, Gleneden Beach, OR.

Mixon, R. B., C. R. Berquist, W. L. Newell, and G. H. Johnson. 1989. Geologic map and generalized cross sections of the coastal plain and adjacent parts of the Piedmont, Virginia. Misc. Invest. Series Map I-2033. Virginia Department of Mines, Minerals and Energy, Division of Mineral Resources.

NatureServe. 2001. International Classification of Ecological Communities: Terrestrial Vegetation. Natural Heritage Central Databases. NatureServe, Arlington, VA.

Newell, C. L., R. K. Peet, and J. C. Harrod. 1997. Vegetation of Joyce Kilmer-Slickrock Wilderness, North Carolina. Unpublished report for the USDA Forest Service, University of North Carolina at Chapel Hill.

Rader, E. K., and N. H. Evans (eds.). 1993. Geologic map of Virginia – expanded explanation. Virginia Division of Mineral Resources. 80 pp.

Rodwell, J. S. (ed.). 1991. British plant communities. Volume I. Cambridge University Press, Cambridge. 395 pp.

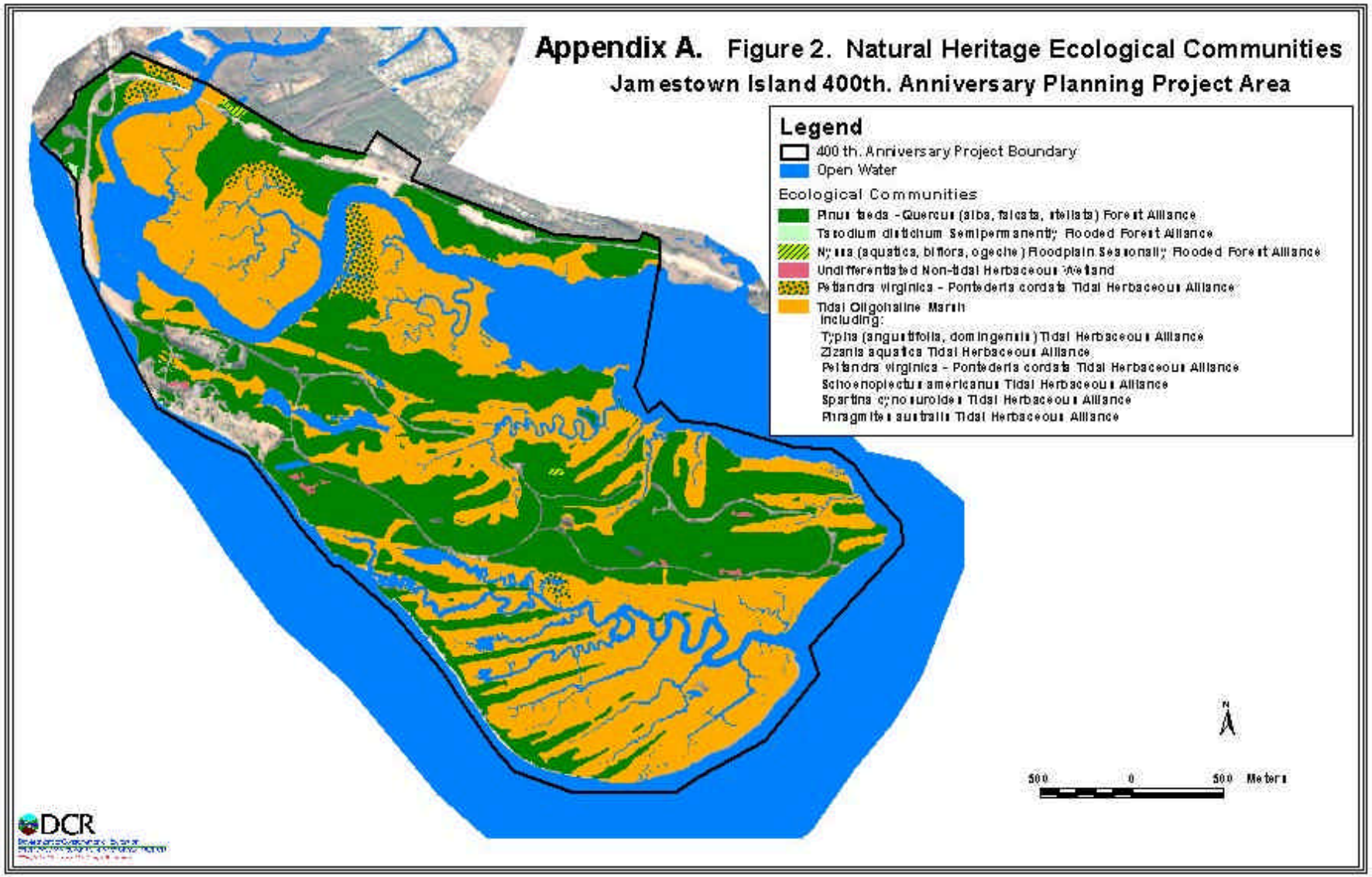
Saltonstall, K. 2002. Cryptic invasion by a non-native genotype of the common reed, *Phragmites australis*, into North America. Proceedings of the National Academy of Sciences 99:2445-2449.

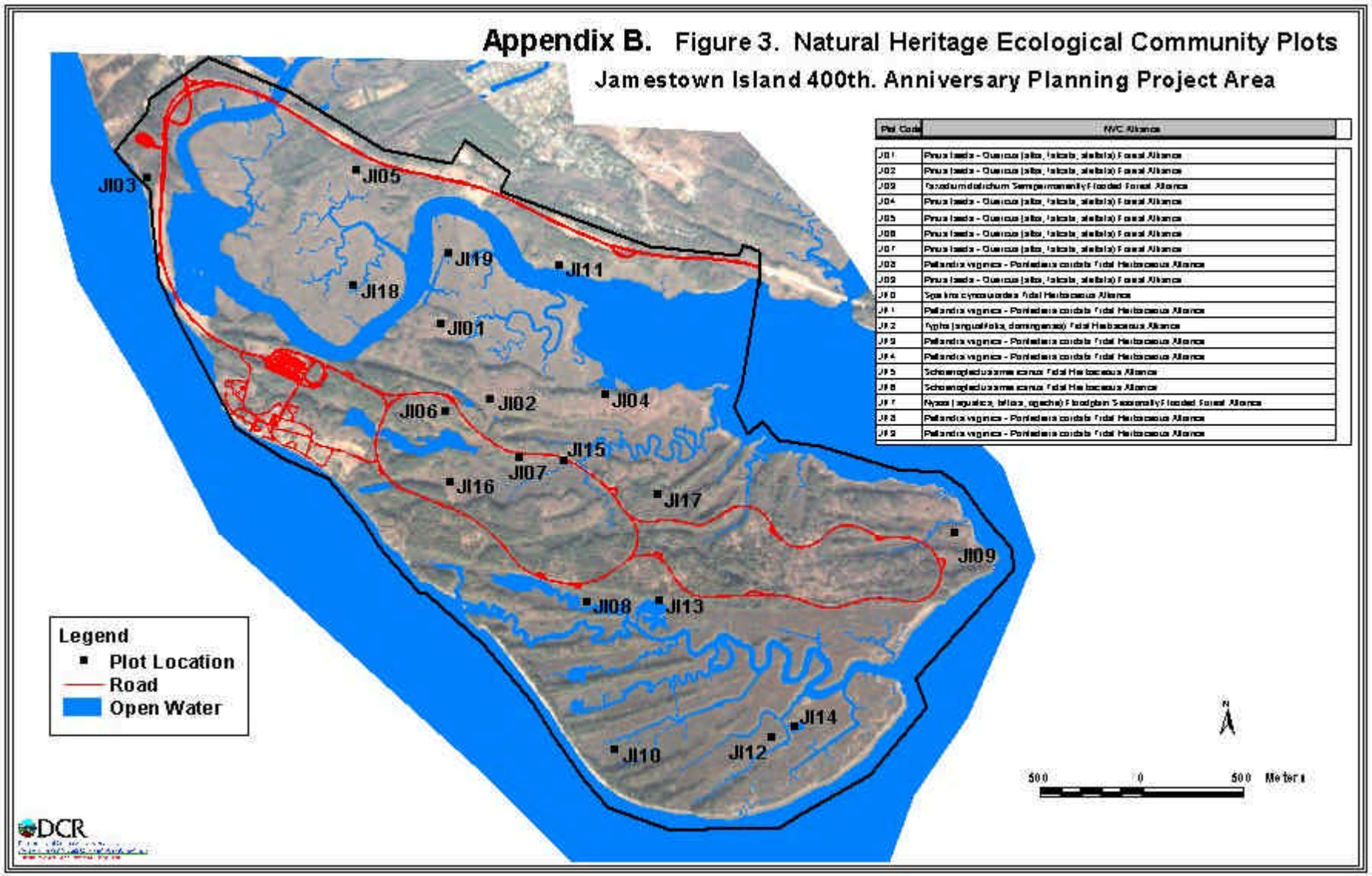
Townsend, J. F., compiler. 2001. Natural heritage resources of Virginia: rare vascular plants. Natural Heritage Technical Report 01-11. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. 30 pp. plus appendices.

Virginia Division of Mineral Resources. 1993. Geologic map of Virginia, scale 1: 500,000. Virginia Division of Mineral Resources.

Walton, D. P., P. P. Coulling, J. T. Weber, A. Belden Jr., and A. C. Chazal. 2001. A plant community classification and natural heritage inventory of the Pamunkey River Floodplain. Natural Heritage Tech. Rep. 01-19. Virginia Department of Conservation and Recreation, Division of Natural Heritage, Richmond. Unpublished report submitted to the U.S. Environmental Protection Agency. 200 pp. plus appendices.

Wilcox, D. A., S. I Apfelbaum, and R. Hiebert. 1984. Cattail invasion of sedge meadows following hydrologic disturbance in the Cowles Bog Wetland Complex, Indiana Dunes National Lakeshore. Journal of the Society of Wetland Scientists 4:115-128.


Appendix A. Figure 2. Natural Heritage Ecological Communities
Jamestown Island 400th. Anniversary Planning Project Area
Legend
400 th. Anniversary Project Boundary
Open Water
Ecological Communities
Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
Taxodium distichum Semipermanently Flooded Forest Alliance
Nyssa (aquatica, biflora, ogeche) Floodplain Seasonally Flooded Forest Alliance
Undifferentiated Non-tidal Herbaceous Wetland
Peltandra virginica - Pontederia cordata Tidal Herbaceous Alliance
Tidal Oligohaline Marsh
including:
Typha (angustifolia, domingensis) Tidal Herbaceous Alliance
Zizania aquatica Tidal Herbaceous Alliance
Peltandra virginica - Pontederia cordata Tidal Herbaceous Alliance
Schoenoplectus americanus Tidal Herbaceous Alliance
Spartina cynosuroides Tidal Herbaceous Alliance
Phragmites australis Tidal Herbaceous Alliance
N
500 0 500 Meters
DCR


Appendix B. Figure 3. Natural Heritage Ecological Community Plots
Jamestown Island 400th. Anniversary Planning Project Area
Plot Code
NVC Alliance
JI01 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI02 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI03 Taxodium distichum Semipermanently Flooded Forest Alliance
JI04 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI05 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI06 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI07 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI08 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI09 Pinus taeda - Quercus (alba, falcata, stellata) Forest Alliance
JI10 Spartina cynosuroides Tidal Herbaceous Alliance
JI11 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI12 Typha (angustifolia, domingensis) Tidal Herbaceous Alliance
JI13 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI14 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI15 Schoenoplectus americanus Tidal Herbaceous Alliance
JI16 Schoenoplectus americanus Tidal Herbaceous Alliance
JI17 Nyssa (aquatica, biflora, ogeche) Floodplain Seasonally Flooded Forest Alliance
JI18 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI19 Pellandra virginica - Pontederia cordata Tidal Herbaceous Alliance
JI03
JI05
JI19
JI11
JI18
JI01
JI06
JI02
JI04
JI15
JI07
JI16
JI17
JI09
JI08
JI13
JI14
JI10
JI12
Legend
Plot Location
Road
Open Water
N
500 0 500 Meters
DCR

JI400 Ecological Communities Study Plots, 2001

Plot 02 - Pinus-Quercus.jpg

Plot 03 A - Taxodium.jpg

Plot 03 B - Taxodium.jpg

Plot 06 Pinus-Quercus01.jpg

Plot 07 - Pinus-Quercus.jpg

Plot 08 A - Peltandra-Pontederia.jpg

Photos by DCR, Division of Natural Heritage

JI400 Ecological Communities Study Plots, 2001

Plot 08 B - Peltandra-Pontederia.jpg

Plot 09 A - Pinus-Quercus.jpg

Plot 09 B - Pinus-Quercus.jpg

Plot 09 C - Pinus-Quercus.jpg

Plot 10 - Spartina.jpg

Plot 11 - Peltandra-Pontederia.jpg

Photos by DCR, Division of Natural Heritage

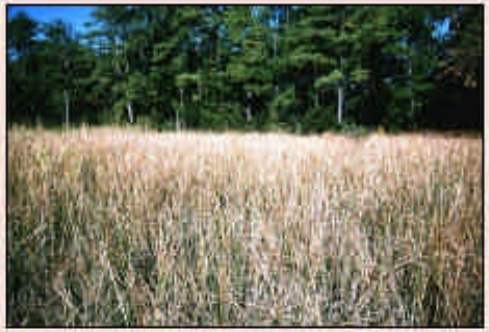
JI400 Ecological Communities Study Plots, 2001

Plot 13 A - Peltandra-Pontederia.jpg

Plot 13 B - Peltandra-Pontederia.jpg

Plot 14 A - Peltandra-Pontederia.jpg

Plot 14 B - Peltandra-Pontederia.jpg



Plot 15 - Schoenoplectus.jpg

Plot 16 A - Schoenoplectus.jpg

Photos by DCR, Division of Natural Heritage

JI400 Ecological Communities Study Plots, 2001

Plot 16 B - Schoenoplectus.jpg

Plot 17 A - Nyssa.jpg

Plot 17 B - Nyssa.jpg

Plot 18 A - Peltandra-Pontederia.jpg

Plot 18 B - Peltandra-Pontederia.jpg

Photos by DCR, Division of Natural Heritage